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Forthcoming Events.

NOVEMBER 8.

British Foundrymen's Association (London Branch).—"Education in Relation to the Status of the Foundry," by Alexander Hayes (London). (Postponed from October 11.)

NOVEMBER 23.

British Foundrymen's Association (Birmingham Branch).—"Foundry Calculations," by E. L. Joselin, Birmingham.

NOTES AND COMMENTS.

A Scottish Ironmaster's Opinion on Education.

In the course of his presidential address at the meeting of the West of Scotland Iron and Steel Institute last month, Mr. W. Dixon referred to the question of the education of manual workers. He remarked that over a somewhat extended period and a wide area, he had made inquiries amongst those who had collectively the control of about 200,000 men in their own and allied industries. It was their unanimous opinion that any book learning outside the rudiments of the "three R.'s" was a matter outside the requirements of the avocation of 90 to 95 per cent. of the usual manual workers; further, that their work would be as efficiently, as successfully, and as expeditiously performed if the men had no school education whatever outside and beyond that mentioned, and that of the remaining 5 to 10 per cent., amongst whom were to be found the chargemen, foremen, and other leaders, most of these would attain to the leading positions through and by their own initiative if three-quarters of the existing aids to learning were abolished, and that the plethora of educational facilities did not raise more than about 1 or 2 per cent. from the worker to the overseer stage. Further, there was a widespread opinion that of the 90 to 95 per cent., not only would the work be done equally well and efficiently were the workmen devoid of their present so-called "education," but it would be done more expeditiously and more satisfactorily, inasmuch as there would be less unreasonable restlessness and less unreasonable discontent.

This appears at first sight a strong pronouncement against the granting of educational facilities to the workers, but on careful consideration it will be found to have a different significance. The gist of the whole subject is too often obscured by confusing the two distinct terms of education and schooling. It would not be any exaggeration to state that some of the products of our present system of schooling are far less educated than their forefathers who could not even sign their own names. Education does not consist in the acquisition of some ability to express in writing more or less badly compiled sentences, to decipher with doubtful completeness the contents of the evening newspaper, and to work very simple problems in simple arithmetic. The ability to read instructions and to express an idea in writing are, of course, very desirable accomplishments in any worker; but when that comprises practically the sum total of good gained by a rather elaborate schooling system, that system is open to criticism. The fact has for years past been observed by employers of labour, that modern so-called education by no means tends to develope the intellect of the worker commensurate with the money and time devoted to the matter. The ability to read crude English, so far from serving as a means to education proper, is often merely the means of diverting the individual's thoughts from the matters most intimately connected with his progress

in his calling, of affording glimpses of phases of life which he has not the education to see in their correct relationship, and of generally engendering discontent without giving the capacity to satisfy or allay it. To simply teach an individual to read, without at the same time training the intelligence to think logically and perceive proportionately, is to lay him open to the mischievous influence of any plausible scribbler of bad logic and high-sounding phrases; and it is the fact that our schooling system, so far as the workers in general are concerned, stops short at the point of serious mental development, which condemns it. Before schooling became compulsory, contact with the requirements of his trade was the main factor in the education of a worker, and in the absence of the distractions provided by an unguided ability to absorb not too profund ideas from print, it may be taken as very probable the unschooled worker operated quite as satisfactorily as the present-day worker. But at the same time, that does not constitute any argument against education for all classes when conducted on the right lines; it rather constitutes a condemnation of the present system of neglecting mental development in favour of cramming the scholar with a few imperfect attainments which are not directed into lines of useful activity. There is probably no trade in existence which could not do with a higher grade of mental development in its rank and file workers; but mere schooling on present lines offers poor prospects of attaining that. The process of instruction in the "three R's" may, by accumulated effect over a few generations, stimulate the nation to its self education, but the process is a long and wasteful one. We will revert to this subject in closer detail in an early issue.

The Pig-Iron Grading Question.

Among the advocates in America of chemistry in the grading of pig-iron, probably there is none so strenuous as Mr. Thos. D. West, who read a brief Paper on the subject before the Buffalo Convention of the American Foundrymen's Association. In this Paper he vented his opinion of the fracture-grading system in somewhat scathing terms, remarking that the man never lived, or is alive to-day, who could reliably define by the fracture of the current brands of pig the grade of the casting they would produce when remelted; any attempt to do this was the merest guess-work. "In the old days," he continued, "when fracture grading was in vogue, and the predictions made did not come true, it was laid to a mistake in taking iron from the wrong pile in the yard, or to the coke having been exceptionally dirty. Hard iron or steel might have been mixed with the scrap, the charges badly mixed or laid on unevenly. Then, again, the coke might have been too soft for that pig-iron, or the blast not strong enough, or even too strong; a damp atmosphere; too small a bull-ladle; iron right, but moulds wrong. In short, anything but the wrong guess in fracture grading. Even to-day there is added in such cases the possible excuse of high sulphur in the coke."

To a great extent these criticisms are justifiable; but, as we have on several previous occasions pointed out, grading by fracture arose in the days when the brand of an iron could be generally accepted as a fair indication of its chemical composition, and the fracture gave an indication, not of the composition so much as of the condition in which the constituents existed. The importance of this lies in the fact that the pouring and cooling conditions, and also the conditions of smelting at the blast furnace, exert a very marked influence on the pig-iron; for it is generally acknowledged, even by advocates of grading by analysis, that two irons of the same ultimate chemical composition may differ greatly in physical properties. Since the remelting under foundry conditions does not absolutely modify these differences, it is evident that the fracture appearance has some significance. The great trouble is that it affords only half the index required, the other half being the chemical composition of the metal. For these reasons neither analysis nor fracture alone can be taken as a definite guide in selecting an iron, though under modern conditions analysis probably is the more reliable, in view of the variations occurring in the composition of many irons.

But to return to Mr. West. He continues:—"One of the most striking situations proving that the use of chemistry in the foundry can enable rapid fracture tests of the resulting molten iron to be made with remarkable success is seen in the car-wheel works. Without the purchase and mixing of the pig-iron by analysis, it would not be possible to get the remarkable uniformity in the little chill blocks which are cast every tap, let stand five minutes or so after solidifying, plunged into water, and broken to display the fracture. These blocks, some 2 in. by 2½ in. by about 8 in. long, with one side chilled to show the character of the metal as it would be found in the chilled part of the wheel, can be made to show an almost perfect uniformity day in and day out. This is only possible when analysis is used to base work upon." The utility of analysis under these conditions, it must be admitted, is undeniable, and is certainly a strong contention in its favour; but against that must be set the admitted fact that analysis alone has not proved satisfactory for a variety of other work—at any rate, so far as British practice is concerned. Car-wheel work is a more or less special class of work, and the irons employed are confined to a certain range. In these circumstances analysis may be accepted as a fairly certain guide. But the difficulties associated with other classes of work are practically admitted by Mr. West in his Paper, in which he later says: "Judging brands and grades of pig-iron are two different propositions. We can readily tell a charcoal pig from a coke pig; but, as between two foundry irons or Bessemer irons, it is difficult to tell two brands apart. In fact, it is practically impossible to do so. A change in the ores used by a furnace really creates a new brand, and even with the same analyses, two irons from the same furnace, but made of different ores, are apt to give different results when remelted."

We are inclined to agree with Mr. West in his further contention that "the only proper physical test of quality of pig-irons is to remelt them and cast test bars of standard size and under standard conditions; with this knowledge, and the comparison of other such tests of brands, the founder is reasonable safe to go ahead with a new brand."

But for ordinary foundry practice we cannot condemn absolutely the use of fracture appearance as a guide in determining the nature of the metal. If used without any regard to the chemical composition it may be hopelessly misleading; but if used in conjunction with analysis, and as an indication of the conditions in which the constituents, particularly the carbon, exist, it may still remain a very useful aid to the founder.

Education in Relation and the Status of the Foundry.

Owing to unforeseen circumstances, the meeting of the London Branch of the British Foundrymen's Association, which was arranged for October 11, could not be held. The Paper on "Education in Relation to the Status of the Foundry," by Alexander Hayes, will accordingly be presented at the next meeting, on November 8.

The Education of Apprentices in Germany.

By Dr. Otto Brandt, (Secretary, German Foundrymen's Association).

The following are extracts from a brief Paper presented before the American Foundrymen's Association at the Buffalo Convention.

The foundry is one of those industries which has to provide for its own supply of skilled men, since there are no other related industries which could serve in any way, or be useful as preparatory agencies for the trade of a moulder. Not even the skilled moulder in one class of moulding is always able to use his skill successfully in another class. Hence the problem of the training apprentices in the foundry is the more important, since the burden has to be assumed almost exclusively by the foundry itself. The problem is not made easier by the fact that there is a prejudice among young people against learning the trade of a moulder, and notwithstanding good wages, the supply of good moulders seems to be decreasing rather than increasing.

The rules under which apprentices are accepted in Germany are quite uniform. They are based upon the customary written apprenticeship contract with a trial period and an increasing scale of wages, the latter generally beginning with ½d. per hour the first year, with 1s. additional per week; ¾d. per hour the second year, with 1s. 3d. additional per week; 1d. per hour the third year, with 1s. 6d. per week additional; then 1¼d. per hour the fourth year with 2s. per week additional. At some places a little more is paid. This has naturally brought out the question whether more boys would not be attracted to learn the moulder's trade if the pay were better. In some large shops the best boys are given piecework during the last year to give them an opportunity to earn more.

It is frequently the custom to assign an apprentice to the care of a skilled workman as a helper in order to receive practical instruction. Only such workmen are selected who are able to give proper instructions. The increase in earnings of the workman due to the help of the apprentice are his compensation for teaching the boy. If, however, the boy makes rapid progress and the foreman notices the earnings of the teacher-workman rises rapidly, due to the efficient help of the boy, then the boy's pay is gradually deducted from the earnings of the workman, and if still rising then the workman is requested to give the boy some extra compensation. In order to attract boys and to prevent their gravitating towards the larger industrial centres, premiums are often paid ranging from £4 to £15, payable at the expiration of the apprenticeship.

Apprentices everywhere are compelled to deposit a small amount of their earnings with the works' saving fund, which is returned with interest at the end of the apprenticeship. The character and extent of the apprentice school at a works is naturally determined by its nature and extent, whether it is a general apprentice school without specialisation for special branches, or whether it is an industrial continuation school with special branches. Thus, where the foundry is a department of a machine shop or electrical works, the foundry apprentices are often formed into a special class with instruction pertaining to foundry work, provided there are enough boys to form such a class. If there are not enough to form special classes, then all are given general instruction in the industrial continuation school. Or groups of co-related branches, like moulders, pattern-makers, and machinists are instructed together.

With some concerns all apprentices are instructed together during the first year and specialised instruction given in the following three years. There is no uniformity as to subject matter or time taught. It varies from a school with one class and four-hour instruction per week only, to a complete three-class system with a preparatory school and twelve hours per week instruction. Again, with some schools purely technical subjects, applying directly to the work on hand, are considered only, while others and the majority of them carry out the regular continuation school curriculum with such additions or deductions or specialisation as necessity or convenience may demand.

Every employer has to send his employés under eighteen years of age to a continuation school for a prescribed number of hours per week, be it a shop school or a school provided by the municipality. Every employer is at liberty to maintain a school of his own on his own premises at his own expense. But if so, the school must conform to certain government requirements concerning number of hours taught per week and given subjects. The school is not allowed to fall below this standard. The employer may go above this standard to any length he desires.

The subjects taught include German language, civic affairs, shop practice, knowledge of materials (including specialised instruction pertaining to one particular trade), metallurgy, arithmetic, book-keeping, natural science, physics, geometry and drawing. One or other of these subjects, as, for instance, book-keeping, may be left out and the time given to a certain subject may vary, according to the special needs of a concern.

The time arrangement is likewise a matter of convenience with each concern maintaining a shop school. Some have school from 7 to 9 a.m., or 5 to 7 p.m., or any other hour. Some have school for an hour and a-half or two hours on Sunday. Sunday school work, however, is not frequent any longer, neither with municipal industrial schools nor with shop schools.

A few details of only one typical school are here presented :—

German Language.—Two hours per week. First year.

Letter Writing.—Business Practice, Bills, Receipts, Shipping, Notices, Postal and Railroad Forms, etc., Compositions, Reading and Discussions of Trade Topics.

Materials.—Two hours per week.

Metals.—Their ores, where found. Processes of conversion. Blast Furnace, Cupola, Bessemer, Open-hearth Furnace, Crucible, Malleable Iron, Alloys, etc.

Woods.—Kinds, and their Properties, Diseases, Protection.

Arithmetic.—Two hours per week.

Business Arithmetic.—Cost of Materials, Buying Materials, Freight Charges.

Weight of Different Metals.—Mensuration.

Drawing.—Six hours per week.

A continuation of the same subjects during the remaining three years of apprenticeship, twelve hours each week, suitably enlarging and broadening the knowledge of the subjects presented, specialising where necessary. During the last two years business law, civics and industrial history are added.

In some instances the German language and civics are either entirely neglected or receive but scant attention.

The wisdom of the practice, indulged in in some quarters, of laying excessive stress upon the acquisition of purely technical subjects, may be questioned. In the pursuance of everyday shop routine the average

working-man does not require such a surplus of technical knowledge. In this respect we may all agree with the recent decree by the Minister of Commerce and Industry of Prussia, concerning the curriculum and equipment of the industrial continuation schools, when he says: "The compulsory industrial continuation school should aim at the vocational education of the young people between fourteen and eighteen years of age, to promote that education and to educate them up to become valuable citizens and respected men." It is gratifying to note the willingness of the management of all works to arrange for school hours during day time, and to provide the necessary school material either free or at cost.

Shop schools are necessarily limited in numbers and it is therefore gratifying to acknowledge the willingness of the municipal compulsory schools to adjust themselves to the necessities of local conditions and, when desirable, arrange special trade classes. Thus, in Düsseldorf, of 214 classes in the industrial continuation schools only 74 were general; all others were special. As these schools are now constituted, the foundry derives but little benefits from them unless they are to be equipped for foundry work.

Cores and Core-Sand Mixtures.

By R. C.

If particulars were taken and records kept of every waster made in the foundry, say, for twelve months, probably a large percentage would have to be set down to faulty cores, and it would then be realised what a very important part of the foundry the core shop is. The writer was working in the United States when the Moseley Commission visited that country in 1902, and he then met Mr. Joseph Maddison, who was representing the Ironfounders on that Commission. Mr. Maddison remarked that what had impressed him most in the foundries in the States was the high quality of the cores there made for small, intricate work, and how the making of these cores had been simplified, compared to British practice. Much progress has been made in this country since then, although there is still a large number of foundries working along the lines followed 30 or 50 years ago.

Let it be clearly understood at the commencement that, like almost every other phase of foundry work this question of core-sand is one upon which no definite rules and regulations can be laid down, but rather general principles. Everyone must be guided more or less by (1) the class of work, and (2) the sand that is cheapest and easiest to obtain. While, however, it is not possible to lay down fixed rules and regulations, we can draw from each other's experience, and the writer proposes to give a number of mixtures that he has used in this and other countries.

In America binders are extensively used, and this is largely due to the fact that on the whole, their sands have not as much alumina as the sands found in this country and on the Continent. The binders most frequently used for medium and heavy-work cores are flour or molasses, more especially the former.

The following is a common mixture in every-day use in foundries in America:—3 of Lake or bank sand, 1 of moulding sand, 1 to 12 or 1 to 14 of flour, wet with clay-water. This is used very largely for making the body cores of steam and gas engine cylinders from, say, 10 in. to 30 in. diameter, such as, in this country, are largely spun on a barrel in loam. The smoke and gases from the flour-sand cores are very obnoxious, and these, in addition to the smouldering of the wood flasks so largely used in the States, brings to the memory of the writer many unpleasant hours at casting time.

Artificial binders are not used to any extent in this country, and, in fact, in the majority of cases are quite unnecessary for ordinary work; but there is plenty of scope for them for intricate and difficult cores. In many foundries it is the custom even to-day to use all new sand (either red or yellow, according to district) for both large and small cores. This is a waste of money as there are very few cases where it is necessary to use all new sand, and, generally, better results can be obtained by the use of a percentage of black sand. The following are the mixtures used by the writer:—

For heavy work.—60 per cent. new sand (Ensall), 40 per cent. black sand (or waste sand), with an average of about one bucketful of horse-dung to a barrowful of sand.

For medium work.—50 per cent. new sand, 50 per cent. black sand, with manure as above.

For rather light work.—40 per cent. new sand, 60 per cent. black sand, with a small quantity of manure.

The class of work for which these mixtures are used includes machine tool, gas engine, and general jobbing work. The cylinders, pistons and liners for gas engines are all made in dry sand from the medium mixture, and the average weight of the castings is about 5 or 6 cwts., and an average thickness of 1 in. to 1½ in. The sand out of these moulds is used over and over again, fresh manure being added; the sand is wet with clay-wash and ground over, and occasionally a little rock sand added.

The new sand is known as "Ensall," and is practically the same as "Doncaster," and with approximately the following analysis:—SiO_2, 88 per cent.; Al_2O_3 7.20 per cent.; FeO_2 1.20 per cent.; CaO 0.20 per cent.

Another class of core for which an entirely different mixture is used comprises some small cores, which are made in large quantities on the machine; these cores have eight small seatings formed in them, and the machining allowance on these seatings is slightly under 1-32 of an inch; consequently they are not blacked, as there is the danger that if the blacking gets too thick it will rob the cores of the necessary machining allowance on the seatings. The following mixture is used:—50 per cent. sea sand; 50 per cent. gangway sand. One pound of core-gum and one pint of glutrin are used as binder, and one shovelful of composition blacking is added to help to skin clean. These cores fall out of the castings very easily, and leave a nice clean hole. There is one drawback to the use of this sand, viz., it is very adhesive and sticks badly to the core boxes; to overcome this we use "Partomel" (lycopodium substitute), instead of ordinary parting sand, and this gets over the difficulty very well.

As to mixtures having artificial bonds, here there is a wide field for scientific and practical research, and one which is likely to yield profitable returns to those chemists and practical moulders who are sufficiently bold and enterprising

to utilise and apply the results of their researches in commercial undertakings. The majority of the readers of the FOUNDRY TRADE JOURNAL will, no doubt, be more or less conversant with the use of sea or sharp sand bonded with an artificial binder for the use of very intricate and difficult cores, but it is astonishing what a number of moulders or coremakers have neither used nor heard of cores of this character. For the benefit of such, the writer will briefly enumerate a few jobs for which these cores are specially adapted, and for which they possess advantages over a naturally bonded sand mixture. For ports, steam-chests, jackets, valves, motor cylinders, pumps and all small intricate cores, such cores are infinitely better than a naturally bonded sand. They are easier to make, require less ironing and venting (in fact, in almost every case they will do without ironing and venting), can be left in the mould longer without danger of blowing, offer less resistance to the contraction of the casting, and are more easily cleaned out of the castings, resulting in time saved in the fettling shop. The best and strongest cores of this character are obtained by selecting a pure washed silica sand and mixing with raw linseed oil, say, 1 of oil to 40 of sand, but owing to the high price of raw linseed oil at present the cost of using that binder is nearly prohibitive for foundry purposes. Whale oil and Menhaden oil are both good binders, but give off disagreeable odours when the moulds are poured. Spermoline makes a splendid core, but this, too, is rather expensive. As a result of a series of tests and experiments, the writer is using a mixture of oils that make a core equal to either linseed oil or spermoline, and is much cheaper.

The following are given as fair samples of oil-sand mixtures:—

1.—14 quarts of sea sand and a full half-pint of linseed oil.

2.—1 cwt. of sea sand and 1 pint of spermoline.

3.—1 cwt. of sea sand and 1¾ pints of whale oil or menhaden oil.

In conclusion it should be noted that all oil-sand cores are weak when green, and special precautions have to be taken to support them until they are dried. Further, they require a hot fire to bake them, and should be baked until they are a golden brown.

No reference has been made to methods of mixing and grinding, etc., but it may be mentioned that, in regard to the oil-sand, the coremaker mixes his own sand as he requires it, by merely pouring the required quantity of oil on the sand and then rubbing through a ¼ in. mesh riddle, no grinding or special mixing being necessary.

Melting Aluminium.

Before the American Institute of Metals at the recent Convention at Buffalo, the question as to the best methods of melting aluminium for use in making aluminium castings was discussed. Mr. E. S. Sperry stated that his experience was that the best results in melting aluminium were obtained by using a cast-iron pot, heated by an oil furnace, the precaution being taken not to allow the flame to come in contact with the metal. Mr. Merritt stated that he had met with success in melting aluminium in graphite crucibles heated with producer gas. A Detroit brass founder reported that he had practically displaced crucibles, and was using iron pots almost exclusively in melting aluminium and with better results. In answer to a question why hard spots frequently appear in aluminium castings melted in iron pots, it was stated that they are caused by the pots not being absolutely clean. When the liquid aluminium is poured from these pots part of the iron oxide in the pots comes along with it.

Expansion Troubles.

One of the most frequent causes of trouble in gas-engine practice is the fact that the range of temperatures in all internal combustion engines is so high. Unless very carefully designed there is a danger that severe working stresses are thrown upon the material of the castings, causing them to ultimately fracture at their weakest points, and the unequal expansion of internal and external pipes has caused many fractures of either the internal or external walls of the engine. This will be readily appreciated by reference to the sketch, Fig. 1, where it will be seen that on the one side there is an external atmosphere of about, say, 20 deg. C., while on the inside there is a passage for gas which may be heated quite easily to about 700 deg. C.

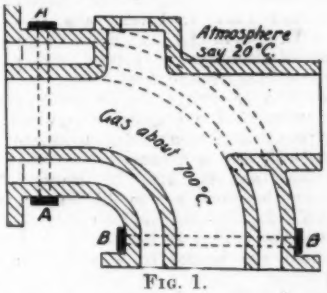


FIG. 1.

In cases where the external pipe has become fractured for the above-mentioned reason, but when the internal pipe has remained sound, a very good remedy may be applied which has also been found to allow the plant to work with the outer pipe cracked. At the point A and B marked on the sketch it has been found advisable to cut a rectangular groove about ¼ in. wide and then to fit over the opening thus caused a ring or plate tightly clamped. The effect of this is to give a kind of expansion joint, which entirely relieves the strain upon the casting, while at the same time retaining all the properties of tightness. It will be found that this very simple remedy will prove of very great value, especially in cases where the engines are of large capacity and the castings are therefore necessarily of a large and heavy nature.

Oxygen in Brass.

In a Paper read before the Institute of Metals recently, Professor T. Turner, M.Sc., points out that brass ingots which have been poured at too low a temperature, and metal which has been rolled and annealed, are sometimes brittle and unsatisfactory owing to the presence of oxygen. This oxygen does not appear to be dissolved in the metal, nor to exist in the form of a eutectic, as is the case with copper and copper oxide. Oxide of copper cannot exist in melted brass, as it is immediately reduced by zinc with the formation of oxide of zinc. Oxide of zinc appears to be insoluble in brass and in zinc. The action of the oxide of zinc in spoiling the mechanical properties of brass, appears, therefore, to be merely that of a foreign brittle body or powder which prevents the particles of brass from coming into metallic contact with each other. The estimation of oxide of zinc in brass presents special difficulties. Experiments are described which show that the methods adopted for the determination of oxygen in copper are not suitable for brass. A ready and accurate process is still required by chemists employed in connection with brass manufacture.

The Growth of Cast Iron after Repeated Heatings.

PARTS V. and VI.

By Professor H. F. Rugan (Professor of Mechanic Arts, Tulane University of La., New Orleans, Louisiana, U.S.A.).

Before the Autumn Meeting at Leeds, last month, of the Iron and Steel Institute, Professor Rugan presented a Paper comprising Parts V. and VI. of "The Growth of Cast Irons After Repeated Heatings." This subject, it will be remembered, was taken up by Professors Rugan and Carpenter, who jointly presented Part I. before the Institute in September, 1909. Parts II., III., and IV. represented the researches of Professor Carpenter, who presented them before the Institute in May, 1911.

Part V. of the following Paper shows the comparative strengths of the original alloys with those subjected to heat treatment until ultimate growth had been obtained, and is a continuance of the original investigations as set forth in Part I.* All references made, therefore, are to this Paper, namely, Part I. Table I., for convenience sake, is partly made up from the tables to be found in Part I., where references are made to chemical analyses, growth, or volume.

Part VI. of this Paper is a synopsis of a report made by the author on tests made of material taken from a large separator that failed while in service in one of the large power plants in the city of New Orleans. The author offers it, believing that it has a bearing upon this research work, and would be of interest to the members of the Institute.

The preparation of the samples was made as follows:—The samples of grey irons were threaded to ¾ in.—10 threads on the ends, with 2 in. at the centre turned and ground to ½ in. The samples of white irons were ground throughout, being reduced a little at the centre to ensure breakage at that point. Table I. gives the chemical analysis of each of these alloys, their change in volume and weight, as well as their original and final strength per square inch. The physical changes occurring in all the grey irons, as observed under the microscope, closely followed those shown of sample "P" (pp. 98—102, Part I.).

Microsections of the original white irons showed under the microscope a homogeneous mass of iron carbide in iron, varying in structure with the percentage of carbon present. Microsections prepared from the treated samples showed a considerable change. The continued heating of the white irons, having oxidised the carbon present in the outer zone of each sample, left it entirely free of carbon for depths varying from ½ in. to $\frac{5}{16}$ in.; the core, however, being but slightly changed in appearance from the orignal. It was impossible to accurately determine the exact area affected. An effort was made, however, with sample "D" to arrive at a close approximation of these changes, with the following results.

The original volume of this sample was 4.12 cubic inches. The unaffected volume was 2.52 cubic inches, thus leaving 1.66 cubic inch, or 9 per cent. of the sample that had undergone the change. With a weight of 601.38 grammes and a carbon content of 2.59 per cent., there would be present 15.6 grammes of carbon in the entire sample. Thirty-nine per cent. of this, or the amount of carbon that had been in the affected portion, would have been 6.08 grammes. The original weight of 601.38 grammes, less the final weight of 595.55 grammes, shows a loss in weight of 5.83 grammes; 6.08 grammes, the estimated loss of carbon, less 5.83 grammes, the loss in weight, leaves 0.25 gramme unaccounted for. This discrepancy can be easily accounted for when the difficulty encountered while attempting to make measurements is considered. This close approximation between the loss of carbon and the loss in weight would seem to be self-explanatory.

A chemical analysis, made of the material forming the outer ring mentioned, showed practically no carbon present. The extent to which these changes will progress in the metal is in no way definitely shown. It may be assumed, however, that the change observed may continue throughout the entire mass with an increased number of heats. The increased strength shown in alloy "C" seems to corroborate the recommendation made in the concluding paragraph of Part I., "that this alloy is suitable for annealing ovens, ingot moulds," etc.

In the low-carbon alloys, particularly "I." a second change seemed to have taken place. The core of this sample for about ¼ in. in diameter showed a trace of iron carbide in iron; in appearance about equal to the original. Immediately surrounding this core was a zone of pure ferrite about ¼ in. width, while the outer layer showed the presence of carbon in a greater percentage than in the original. This seems to indicate that after the decarburisation had taken place during the earlier heats, it was followed by a cementation process influencing the outer layer.

These changes seem to be corroborated by the changes observed in the weight of this sample which, beginning with 336.54 grammes, fell to 336.33 after twenty-five heats, and weighed 336.61 grammes after the thirty-ninth heat.

Unfortunately, there was none of the original of sample "O" left with which the author could obtain its original tensile strength. When compared with the tensile strength of original alloys of similar mixture, however, it will be seen that the sample "O" lost about 75 per cent. of the total loss in strength observed at a time when it had grown about 75 per cent. of its ultimate growth. This would seem to indicate that in grey irons the loss in strength progressed, practically, with its increase in volume—that is, decreasing rapidly during the earlier heats and losing little during the later heats, where the rate of growth materially decreases.

Summary for Part V.

(1). Grey irons lose approximately 75 per cent. of their original strength due to heat treatment, as illustrated in samples "P.C., P.H, and F.H."

(2). Grey irons lose their strength in a greater degree per heat during the earlier heats.

(3). White irons, as alloys "C and D," do not lose in strength, but on the contrary become stronger and more ductile under heat treatment.

* See Foundry Trade Journal, November, 1909.

(4). The alloy "C" appears to be a suitable material for such articles as annealing ovens, ingot moulds, grate bars, and similar castings.

The Failure of a Cast-Iron Steam Separator while in Service.

The conditions the separator had been under while in service were as follows. When the plant was started saturated steam had been used in the pipe system; later this was changed to superheated steam with temperatures, as observed, varying from 370 deg. F. to 470 deg. F.; these temperatures fluctuated frequently. All fittings used in the pipe line were tested to a pressure of 300 lbs. per square inch before being installed. In order to obtain definite information regarding the material used in the separator, seven specimens were made from the broken pieces. Three of these were from parts $\frac{3}{4}$ in. thickness, and four from parts 1 in. in thickness. These specimens were turned to $\frac{1}{2}$ in. in diameter at the centre and threaded to $\frac{3}{4}$ in.—10 threads on the ends, and broken with the results given in Table II.

TABLE I.

Specimen.	Carbon per Cent.	Silicon per Cent.	Manganese per Cent.	Sulphur per Cent.	Phosphorus per Cent.	Number of Heats.	Change in Volume.	Change in Weight.	Original. Diameter.	Original. Area.	Original. Load.	Original. Pounds per Sq. In.	Final. Diameter.	Final. Area.	Final. Load.	Final. Pounds per Sq. In.	Percentage of Original.
P.C.	3·48	1·13	...	...	...	99	37·50	8·00	[1]0·4989	0·1955	4,404	22,526	0·5003	0·1965	960	4,845	21·6
P.H.	3·48	1·13	...	...	...	99	39·70	8·50	[1]0·4987	0·1953	4,233	21,847	0·5000	0·1963	1,000	5,094	23·3
F.C.	3·41	0·95	...	...	...	99	35·21	7·86	[1]0·4988	0·1953	4,497	23,011	Broken	while being	machined		
F.H.	3·41	0.95	...	...	...	99	35·70	7·82	[1]0·4989	0·1954	4,412	22,573	0·5000	0·1963	1,150	5,858	25·9
C	3·08	0·172	0·13	0·019	0·010	87	−0·84	−1·29	0·9440	0·6998	19,150	27,364	0·9420	0·6969	32,390	46,477	169·8
D	2·95	0·146	0·12	0·016	0·012	87	−0·822	−0·97	0·9385	0·6917	31,150	45,034	0·9350	0·6866	41,250	60,078	133·4
F	1·58	0·168	0·17	0·015	0·014	48	0·29	−0·43	0·9107	0·6513	46,050	70,704	0·9655	0·7320	47,870	65,396	92·4
G	0·99	0·233	0·19	0·015	0·012	48	1·35	−0·12	0·9788	0·7524	71,200	94,630	0·9683	0·7363	55,050	74,768	79·0
H	0·55	0·182	0·20	0·013	0·014	48	0·113	−0·02	0·9721	0·7421	58,630	79,140	0·9703	0·7393	51,860	70,147	88·4
I	0·15	0·186	0·15	0·04	0·017	48	0·80	0·03	0·9805	0·7549	45,180	59,848	0·9665	0·7335	33,450	45,603	76·1
N	3·98	1·07	0·25	0 01	0·013	26	15·00	0·65	0·4999	0·1955	2,540	12,992	Broken	while being	machined		
O	3·98	1·79	0·23	0·01	0·013	26	23·10	1·89	[2]0·4988	0·1954	690	3,531	0·4985	0·1951	470	2,405	...
P	3·79	2·96	0·25	0·01	0·012	27	32·75	3·66	0·4988	0·1954	1,740	8,904	0·4963	0·1934	680	3,510	39·4
Q	3·76	4·20	0·27	0·01	0·012	52	43·90	9·59	0·4988	0·1954	2,550	13,050		Cracked during heat treatment			
R	3·79	4·83	0·30	0·01	0·012	52	59·50	10·25	0·4977	0·1945	1,750	8,997					
S	3·38	6·14	0·30	0·01	0·013	32	63·00	13·20	0·4976	0·1944	2,630	13,528					
T	0·17	0·65	0·17	0·045	0·017	15	−0·025	−0·04	0·4960	0·1932	6,420	33,299	0·4953	0·1926	5,700	29,594	89·0
U	0·18	1·10	0·19	0·049	0·022	15	nil	−0·03	0·4951	0·1925	5,950	30,909	0·4981	0·1948	5,200	26,698	86·3
V	0·19	2·71	0·20	0·051	0·033	15	0·394	−0·02	0·4982	0·1949	6,240	32,016	0·4978	0·1946	7,800	40,082	125·1

[1] Average of several specimens.

[2] After eight (8) heats.

TABLE II.

Tensile Test of $\frac{3}{4}$-inch Metal.

Mark.	Diameter.	Area.	Breaking Load.	Stress.
V.	0.4982	0.1949	2,750	14,100
VI.	0.5000	0.1963	2,930	14,900
VII.	0.4945	0.1920	2,770	14,420
Mean average				14,473

Tensile Test of 1-inch Metal.

Mark.	Diameter.	Area.	Breaking Load.	Stress.
I.	0.4905	0.1888	2,220	11,750
II.	0.4985	0.1951	2,080	10,660
III.	0.5002	0.1964	2,190	11,140
IV.	0.4940	0.1916	2,300	12,000
Mean average				11,387

The thinner metal cooling sooner shows a higher strength than the parts that were thicker, and therefore more slowly cooled. This difference in strength almost compensates for the difference in the thickness of the metal.

Classing the separator as a medium casting, and assuming that a test specimen taken from such a casting would about equal 90 per cent. of the strength of a test-bar cast at the time of casting, it will be seen that these samples were much lower than the strength required for medium castings in the standard specifications for cast iron adopted by the American Society for Testing Materials, which is 21,000 lbs. per square inch in a bar $1\frac{1}{4}$ in. square and 15 in. long.

In order to determine if any deterioration had taken place in the casting, due to the heat treatment it had received while in service, three specimens were cut from various parts of the broken pieces of the separator for microsections. These specimens were prepared with great care, every effort being made to ensure a good surface at the extreme edges where they joined the scale surface of the casting.

Upon examination under the microscope, it was observed that the broken-down appearance to be observed in the specimens used in the experiments set forth in Part I. was to be seen in the casting a certain distance in from each surface. This change had permeated 0.0781 in. in from the outer surface of the casting, but had not affected the metal nearly as much as it had upon the inner surface, where it had permeated to a distance of 0.1093 in.

These changes were easily observed, and were compared by inspection with the specimens mentioned above and in the author's possession.

In order to check these observations, the author decided to test the strength of the outer fibre of the surfaces of the casting, and compare them with the fibre stresses of samples cut from the same metal, but immediately behind those cut from the surface. The way in which these cuts were made is shown in Fig. 1.

Pieces Nos. I. and IV. represent the inner surface of the separator, while Nos. I^1., IV^1., and IV^{11}. are samples cut from immediately behind those, and between them and the centre of the casting. Nos. II. and III. represent the outer surface of the separator, while II^1., III^1., and III^{11}. are samples cut in a like manner behind those mentioned above. No data could be found of any tests made and reported showing the relative differences of strength between the fibres forming the scale surface of a casting and

parts taken from the inner portion of the same casting. Comparisons are made, therefore, between the fibre strength of the outer surface of the separator (II. and III.) and the strength of the fibre forming the inner surface (I. and IV.). These values were also compared with the results obtained from the various samples cut from the central portions of the casting.

All samples were approximately 5½ in. long by ⅝ in. wide, and $\frac{1}{10}$ in. thick. The knife-edged supports used for the breaking tests were 4½ in. apart, with the load placed at the centre. These samples were broken with the results shown in Table III.

TABLE III.

Mark.	Breaking load.		Dimensions.		Maximum stress on Outer Fibre.
	Lbs. Ozs.	Lbs.	B.	H.	
I. ..	11 12	11.75	0.638	0.0745	22,400
II. ..	20 15	20.94	0.641	0.0779	36,300
III. ..	22 2	22.12	0.646	0.0806	35,600
IV. ..	36 15	36.94	0.659	0.1162	28,100
I.′ ..	17 11	17.69	0.736	0.0785	26,300
II.′ ..	19 10	19.62	0.643	0.0870	27,200
III.′ ..	16 1	16.06	0.651	0.0784	27,200
III.″ ..	19 5	19.31	0.654	0.0855	27,300
IV.′ ..	34 11	34.69	0.657	0.1107	29,100
IV.″ ..	31 0	31.00	0.655	0.1085	27,100

In order that comparisons may be made easily the results shown in Table III. are rearranged, and aver-

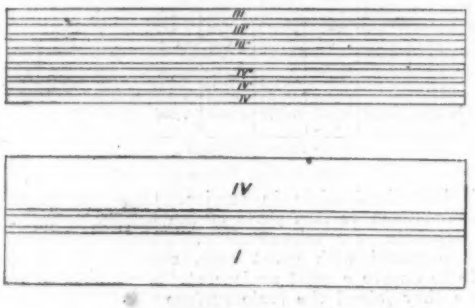


FIG. 1.

ages of stress are shown, from which deductions may be made, in Table IV.

TABLE IV.

Marks.	Outside of Casting.	Mean.
II. and III.	36,300, 35,600	35,950
II.′ and III.′	27,200, 27,200	27,200
III.″	27,300	27,300
IV.″	27,100	27,100
I.′ and IV.′	26,300, 29,100	27,700
I. and IV.	22,400, 28,100	25,250
	Inside of separator.	

By comparing samples II. and III. representing the outer surface of the separator with an average strength of 35,950 lbs. with the average of I. and IV., the inner surface, of 25,250, it will be seen that the fibre strength of the outer surface is about 29 per cent. more than the inner surface.

It is safe to assume that a large part of this difference is due to the deterioration of the casting owing to its heat treatment. It may be assumed that in making the casting the inner surface coming in contact with the face of the core was cooled more slowly than the outer surface that was cooled by the larger mass of the walls of the mould, and therefore the outer surface may be somewhat stronger. This factor has been neglected, however, in the consideration of this matter.

The loss of 29 per cent. of the strength of the inner surface of the casting that was affected to a depth of 0.1 in. would indicate that the total strength of the casting, 1 in. thick, had been lowered about 2.9 per cent. from the original from this cause.

Summary for Part VI.

(1). That the strength of the outer fibres of the scale surfaces of a casting is greater than those of the metal taken from other portions of a casting.

(2). That the temperature encountered in pipe lines using superheated steam is sufficiently high to produce disintegration in a casting, causing it to grow and become correspondingly weak.

(3). That grey cast-iron fittings of ordinary mixtures are unfit for use in pipe lines designed for superheated steam.

Sanitation in American Brass Foundries.

In a discussion before the American Institute of Metals at the Buffalo Convention, recently, on the study of health conditions in the foundry, some interesting data were brought out. Professor Parsons said that he had recently made visits of inspection to a number of brass foundries in different parts of the country, and in some he found sanitation conditions almost ideal, and in others they were bad. One member from York, Pa., stated that the Manufacturers' Association of York had taken up extensively the subject of improved health conditions in manufacturing plants in York with good results. Wash rooms and bath rooms had been installed, and medical examinations of the men employed in his foundry were made, and also in other foundries in that city. Mr. Schultz stated that his company recently installed a large galvanised tub, in which the men wash their overalls and shirts at least once a week, and shower baths had also been installed for the use of their men. Mr. Moerel, of the brass department of the Pullman Company, Chicago, Ill., stated that his company compels the men to take baths regularly, and allows 10 minutes at noon and 10 minutes in the evening for them to wash themselves and take care of their clothes. The company has installed wash rooms, shower baths, and furnishes tooth brushes free to its men, and also a clean pair of overalls once a week. The representative of a large foundry in Western Ohio, stated that health conditions in the company's foundries were the first consideration, and were carefully observed at stated intervals. The shops were swept every day, individual shower baths have been installed, and the company furnishes towels and soap free to its men, and on account of the peculiar location of the foundry fans have been installed to furnish fresh air to the men. Every man before being employed must undergo a medical examination by the doctors of the company, and every precaution is taken to insure the very best health and sanitation conditions.

Electric Lifting Magnets in the Foundry.

The value of electric lifting magnets consists not only in their ability to lift quickly, but also in the facility and rapidity with which their load may be released. Their use under suitable circumstances results in considerable economies both in labour and time occupied and cost of handling metals. For instance, most ironfoundries possess some means of breaking skulls and defective castings, and the old-fashioned and primitive "skull cracker" is still to be seen at work in many foundry yards. Its operation is slow and expensive, and not free from danger. An electro-magnet, however, will pick up the casting to be broken and convey it into position without being handled by workmen at all; it will then lift a spherical ball which is released by simply switching off the current, when the ball falls straight, there being nothing to disturb the aim. Further, the broken pieces are lifted by the magnet; practically none are left lying about; and when skulls containing a considerable amount of slag are being broken, the magnet performs the function of separator, which is a useful feature. The operation is controlled by one man in the crane cage, and he, being well removed from the material being broken, is safe from flying pieces of metal. The work is done much more cheaply, safely and quickly than is possible by the old method, and can be carried out between heats by the same crane employed in filling charging boxes.

Electro-magnets are useful for loading and unloading pig-iron into and from wagons, doing the work probably twenty times as quickly as is possible by hand, with a far less expenditure on labour. Moreover, a magnet unloads *all* the iron, and does not leave the smaller pieces which often account for a loss measured in cwts.

It is important to note that work can be done with an electric lifting magnet under circumstances which would render it difficult or impracticable by other means; *e.g.*, metal may be recovered from under water and also hot metal may be handled. Existing cranes of standard construction and of any type may be employed, electro-magnets being attached and connected up in a few minutes. If electric power is not used for operating the crane, current may be brought to the magnets by flexible cable from an independent power supply, or a small electrical generator set may be fitted on the crane.

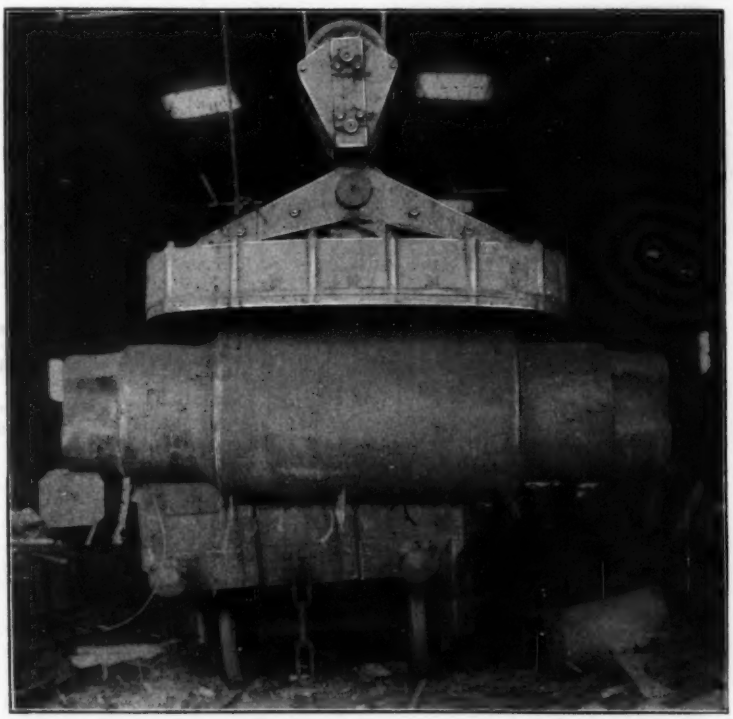


FIG. 1.—PHŒNIX ELECTRO-MAGNET LIFTING CAST-STEEL ROLL WEIGHING 6 TONS 12 CWTS.

The chief trouble of the electro-magnet designer has been to keep the weight of the magnet itself low in comparison with the load it will lift. The majority of electro magnets monopolise far too large a proportion of the lifting capacity of the cranes to which they are attached, to permit of their extensive adoption for use on existing cranes. In the "Phœnix" electro magnet, made by Messrs. E. G. Appleby & Company, 10, Victoria Street, S.W., the relation of the weight of the magnets to the

weight lifted averages approximately 28 per cent.—an exceptionally low figure. Partly consequent upon this there is claimed an actual saving in electrical energy consumed of 16 to 58 per cent. Assuming current to cost 2d. per unit, and that only 5,200 hours are worked per year, the actual saving with a large magnet as against the heavier magnets of equal capacity would represent the sum of £195.

The "Phœnix" electro-magnet has been in actual operation for many years, and is a proved and practical success. Its windings are dust- and damp-proof, and the magnets are suitable for both indoor and outdoor service and for lifting both hot and cold material. The steel used is of very high permeability, and each pole-piece is forged and machined. The energising coils are wound upon solid brass formers, so as to prevent any small particles of magnetic substances being drawn up between the magnet pole-pieces and the energising windings. The windings are protected on the outside by a substantial casing of either brass or steel, and are so treated as to make them dust- and damp-proof. The coils are interchangeable, and are so fixed that it is only a matter of a few minutes to change a coil in case of accident. The magnets are complete with eye-bolts and magnetic blow-outs.

FIG. 2.—PHŒNIX ELECTRO-MAGNET LIFTING 10 CWTS. OF LIGHT SCRAP.

Messrs. Steel, Peech & Tozer have added to the "Phœnix" magnet a remarkably efficient safety device, which is automatic in its action, and has been thoroughly tested in actual use; the main current supply to the crane and magnet has been cut off, and the wires feeding the magnets cut, but the magnets have through the safety device held the load until the current supply was renewed, and then delivered the load at the required destination. For sustaining a load of 5 to 7 tons the device only weighs a few pounds, and is quick and certain in its action. By its use it is claimed that the handling of material by electro-magnets is perfectly safe; in fact, there is no more risk than there is of the breaking of a chain or hook. The apparatus consists of a set of accumulators connected up to two automatic switches carried on top of the magnet frame, in such a manner that should anything go wrong with the main current the accumulators are instantly and automatically connected across the magnet winding. There is a special switch in the driver's cage which enables him to put the accumulators on charge each time the magnet makes a lift, and to disconnect the same when it is necessary for the magnet to release its hold. It is impossible for the accumulators to come into operation across the magnets so long as there is the main current on the magnet feeding wires, and the magnet can only release the load at the will of the crane driver.

The magnets are constructed of special high permeability steel, and the action of the device is as follows:—Say a magnet takes 15 amperes at 220 volts to lift a load of 10 tons; when this 10 tons has been magnetised to a very high degree it only takes a fraction of an ampere to retain the magnetism for holding the load; therefore, by the automatic switching on of the accumulators the load is sustained for any length of time. The steel of which the magnets are constructed is of such a class that in the case of the current being accidentally cut off by broken wires, or other cause, the magnets will retain enough magnetism to hold the full load for a few seconds, and it is impossible for them, unless permitted by the crane driver, to leave hold when once switched on, provided, of course, that the safety device is fitted.

In Fig. 1 is shown a crane which, although designed for dealing with loads of 5 tons only, is shown lifting a load of 6 tons 12 cwts., to which must be added the weight of the magnet—some 23 cwts.

Fig. 2 show the same magnet lifting different classes of scrap, and affords a practical demonstration of the great utility of these magnets for loading light scrap into charging boxes. Indeed, for this purpose, experience has shown that a fuller charge can be obtained by dropping light scrap from the magnet into boxes, this consolidating it more thoroughly than when forked in by hand labour; when it is considered that the load lifted at each operation represents about 15 minutes' work for two men, it will be understood that the amount of labour and time saved is considerable. Before the installation of this crane, which is employed for charging open-hearth furnace with scrap, some 13 labourers were employed in dealing with the scrap, which is now almost entirely handled by the crane driver, with one or two labourers underneath.

The same magnet is employed for handling the pig-iron out of wagons into stock and into charging boxes, and out of stock into charging boxes, and here the load lifted is only limited by the amount of pig which can actually come into contact with the face of the magnet. For cleaning up the floor of such a shed the magnet is invaluable, owing to the fact that when passed over the surface of the ground, within about 12 in., any scrap remaining, whether large or small, jumps to the magnet and leaves the surface of the ground clear.

Another useful application of the electro-magnet has been recently tried with pronounced success, in the lifting of cases containing steel in any shape or form, and of any size within the compass of the magnet, it being found that the magnetic influence will permeate through the packing case and lift the load therein contained with perfect ease.

Convention of American Foundrymen.

At Buffalo, on September 24, 25 and 26 last, the American Foundrymen's Association, together with the American Institute of Metals, and other allied Associations, met together for their Annual Convention. A number of interesting Papers were presented before the Associations, and considerable discussion ensued. The programme of the American Foundrymen's Association's meeting is given herewith:—

American Foundrymen's Association.

Tuesday, September 24.

Formal opening, addresses of welcome and responses, address of the President, and report of the Secretary-Treasurer.

Report on Cast Iron at the International Testing Congress of New York.

Report of the Committee on Coke Analysis.

Report of the Committee on Industrial Education.

"Malleable Cast Iron and the Open-Hearth Furnace," by G. A. Blume, Sweden.

"Memorandum on Titanium in Malleable Castings Practice," by C. H. Gale.

"The Great Economies produced by Continuous Foundry Installations," by Geo. K. Hooper.

"The Foundry and the Pig-iron Market," by A. I. Findley.

"Mechanical Sand Tempering," by V. E. Minich.

"Compressed Air: A Foundry Necessity," by Arthur P. Murray.

"The Heating and Ventilating of the Foundry," by W. H. Carrier.

"Melting Scrap," by A. W. Moyer.

"Some Thoughts on the Problem of the Foundry," by C. F. Dudley.

Wednesday, September 25.

"Electric Welding," by J. F. Lincoln.

"The Electric Furnace in the Foundry," by F. T. Snyder.

"The Economic Side of the Twelve-Hour Shift in the Steel Foundry," by R. A. Bull.

"Some Salient Points of the Modern Steel Foundry," by Samuel R. Robinson.

"Open Hearth Design and Manipulation as applied to the Steel Foundry," by John Ploehn.

"Economical Cleaning of Castings," by B. H. Reddy.

"The Effect of Titanium on Converter and Open-Hearth Steel Castings," by Prof. Bradley Stoughton.

"Discussion on the Revised Specifications for Steel Castings of the American Society for Testing Materials."

"The Bonus System as applied to the Finishing Department of a Steel Foundry," by A. W. Gregg.

"The Detachable Open-Hearth Furnace," by W. M. Carr.

Thursday, September 26.

"Lighting Fires in Cupolas," by A. H. Stein.

"Mystery versus Chemistry in Grading Pig-iron," by Thos. D. West.

"Notes on Close-grained Soft Cast Iron," by Dr. John J. Porter.

"Air Required for Combustion in the Cupola, and a Simple Blast Gauge," by P. Munnoch.

"Government Cupola Melting Tests," by A. W. Belden.

"Rational Cupola Melting," by Dr. R. Moldenke.

"Accident Prevention and Safety Devices for the Foundry," by W. H. Cameron.

"Instruction in Foundry Practice at the Wentworth Institute," by Prof. E. A. Johnson.

"On Patternmaking," by James Glass.

"Recovery of Shot in Small Foundries," by S. A. Capron.

"About Sheradising," by Thos. Liggett, Jnr.

"Some Short Cuts in the Foundry Laboratory," by P. A. Boeck.

"The Importance of Despatching in the Foundry," by C. E. Knoeppel.

Discussion of the Moulding Sand Tests of the Association.

American Institute of Metals.

The programme of this Institute's meetings was as follows:—

Tuesday, September 24.

Official chemist's report.

"History and Achievements of the Institute of Metals of Great Britain," by G. Shaw Scott.

"Work of the Bureau of Mines as it Relates to the Non-Ferrous Metal Industry," by Prof. C. L. Parsons.

Wednesday, September 25.

"The Electric Furnace for Melting Non-Ferrous Metals," by G. H. Clamer and Dr. Carl Hering.

"The Electric Melting of Copper and Brass," by C. A. Hansen.

"The Successful Handling of Manganese Bronze and other Alloys in a Reverberatory Furnace for Foundry Tests and Foundry Practice," by W. R. Dean.

"The Vaporisation of Metals," by Dr. J. W. Richards.

Thursday, September 26.

"The Thermal Diagram, with Special Reference to the Bronzes," by Dr. W. E. Campbell.

"Progress of Work on Boron Suboxide as Used as a Deoxidiser in Non-Ferrous Metals," by Dr. E. Weintraub.

"Test Bars for Non-Ferrous Alloys," by Jesse L. Jones.

"Phenomena Connected with the Tarnishing of Metals," by C. F. Burgess.

"The Influence of Pouring Temperature on Manganese Bronze," by H. W. Gillett.

"Adulterated Core Flours," by H. W. Gillett.

"Metallic Cobalt," by Herbert T. Kalmus.

Friday, September 27.

"The Difficult Art of Casting German Silver," by C. P. Karr.

"Commercial Alloys and the Use of Rare Elements," by Dr. A. Hirsch.

The sessions of the Convention were opened by a joint meeting, in which the American Foundrymen's Association, the American Institute of Metals and the Associated Foundry Foremen participated. Mayor L. P. Fuhrmann, of Buffalo, welcomed the members of the three Associations, and handed the keys of the city to Major Speer, president of the American Foundrymen's Association.

In a brief presidential address, Major J. T. Speer recommended the appointment of a committee to change the by-laws so that more effective co-operation between the various foundrymen's organisations would be possible. He also suggested that the Association consider the problem of providing suitable funds for carrying on is special work, and indicated that this might be accomplished by increasing the membership. Upon a motion in response to Major Speer's suggestion, a committee of seven, headed by Mr. R. A. Bull, was appointed to revise the by-laws.

The secretary, Dr. Richard Moldenke, reported that the membership had been maintained in spite of

many resignations resulting from the recent business depression. The total membership is now 626.

The report of the Committee on Industrial Education was presented at the Tuesday morning's session. Mr. Paul Kreuzpointner, chairman of the committee, urged that steps be taken to insure more effective co-operation between the business men of the various communities and the local boards of education, with the object of establishing industrial continuation schools.

The sessions of the American Institute of Metals were held at the Iroquois Hotel. The report of the Secretary, Mr. W. M. Corse, showed an increase in membership during the year to the total of 310.

Election of Officers.

At the business session of the American Foundrymen's Association, the following officers were elected:—

President: H. D. Miles, Buffalo Foundry and Machine Company, Buffalo, New York.

Vice-Presidents: F. B. Farnsworth, New Haven; T. L. Richmond, Buffalo Scale Company, Buffalo, New York; Walter Wood, R. D. Wood & Company, Philadelphia; Alfred E. Howell, Phillips & Buttorff Manufacturing Company, Nashville, Tenn.; R. A. Bull, Commonwealth Steel Company, Granite City, Ill.; T. W. Sheriff, Sheriff's Manufacturing Company, Milwaukee, Wis.; D. R. Lombard, Lombard Iron Works and Supply Company, Augusta, Ga.; S. B. Chadsey, Massey-Harris Company, Toronto, Ontario.

Secretary-Treasurer: Dr. Richard Moldenke, Watchung, New Jersey.

Major Joseph T. Speer, who completed at the meeting his second term as president, was elected an honorary member of the Association.

A number of changes in the constitution of the Association, submitted by Mr. R. A. Bull for the committee appointed at the first session to do so, were all approved by the meeting, ready for submittal by a letter ballot to the Association. They included the stipulation that associate members may not vote; that past-presidents shall be members of the executive board of the Association; that the vice-presidents shall not necessarily represent definite geographical districts; and that the executive board alone shall determine time and place of annual meetings.

On motion of Dr. Moldenke it was voted that the President appoint a committee on the standardisation of core binders.

An invitation to hold the 1915 meeting in San Francisco in connection with the Panama-Pacific Exposition was read. Invitations received to hold the next annual meeting in Chicago and in Milwaukee were referred to the executive board.

On Friday morning the election of officers for the American Institute of Metals took place. Mr. L. W. Olson, of the Ohio Brass Company, Mansfield, Ohio, was re-elected president, and Mr. W. M. Corse, Lumen Bearing Company, Buffalo, New York, was re-elected secretary-treasurer. The election of vice-presidents resulted as follows:—Vice-president of rolling mills, Mr. W. H. Bassett, assistant superintendent American Brass Company, Waterbury, Conn.; vice-president New England district, Mr. L. L. Belknap, Belknap Manufacturing Company, Bridgeport, Conn.; vice-president Pennsylvania district, Mr. Jesse L. Jones, Westinghouse Electric and Manufacturing Company, Pittsburg; vice-president Illinois district, excepting city of Chicago, Mr. Philip Mueller, superintendent, H. Mueller Manufacturing Company, Decatur, Ill.; vice-president Michigan-Ohio district, Mr. T. O. Clements, National Cash Register Company, Dayton, Ohio; vice-president Chicago-Wisconsin district, Mr. C. E. Hoyt, Lewis Institute, Chicago; vice-president Virginia and the South, Mr. G. H. Clamer, Ajax Metal Company, Philadelphia; vice-president New York and New Jersey district, Mr. F. Reidenbach, Genesee Metal Company, Rochester, New York; vice-president Ontario and Western Canada, Mr. C. M. Ivy, Empire Manufacturing Company, London, Ont.; vice-president Quebec, etc., Mr. Robert Job, vice-president of the Milton Hersey Company, Limited, Montreal, Canada.

New Method for Comparing the Indications of Testing Machines.*

By F. Schule and E. Brunner (Zürich).

The principal laboratories possess standard bars for the purpose of verifying the accuracy of the testing machines by measuring the elongation or shortening of the bar under a given load.

In certain cases use is made of small cylinders of copper (crushers); we verify the shortening which they undergo under the same load in the different machines to be compared. In the most recent installations a known weight is provided under the machine for facilitating the control, and a direct verification of the scale of measurements is made practicable in this way. For machines of small capacity the control and the comparison of their indications are easily effected with the aid of springs of various forms.

A still simpler method for comparing the reliability of the indications of the testing machines would be welcome, even if perfect accuracy could not be attained. It would suffice if we possessed a material whose resistance to crushing would be almost constant for a series of test bars. Such a material exists. It is wood in the shape of slabs of small thickness. Wood has the unique property of offering the same resistance to crushing, whether it be tested in the shape of cubes or in the shape of slabs of small thickness.

From a prism of wood without flaw, a sufficient number of test pieces can be prepared in the shape of slabs, carefully planed, of the same surface and thickness (ranging from 2 to 4 cm). They will be crushed by the machines to be compared, and for testing each machine the same number of test pieces will have to be taken, uniformly distributed over the whole series as cut from the prism. In some tests performed in the Federal Laboratory at Zürich a comparison of three machines of 30, 150 and 300 tons gave, for the 300-ton machine, 606, 588 and 559 kilograms per square centimetre, these figures each being the mean of five tests. The general mean was 586 kilograms per square centimetre. The 150-ton press gave 617, 614, and 557, or a general mean of 599 kilograms per square centimetre. The 500-ton machine gave 596, 599 and 570, or a general mean of 593 kilograms per square centimetre.

The following precautions will have to be observed when applying this method:—

(1) Choose a prism of wood which is well dried without a flaw and about 60 cm. in length. Coniferous wood seems to be most suitable on account of the regularity of its structure.

(2) The number of test pieces for each machine to be compared should be sufficient (five or six) in order to ensure a good mean and a verification of the constancy of the strength of the wood.

This method dispenses with all measurements of deformation which would necessitate the use of instruments of precision.

* Abstract of Paper read at the New York Congress of the International Association for Testing Materials.

A Survey of Foundry Progress.

By Wm. Mayer.

In the course of his presidential address delivered before the Scottish Branch of the British Foundrymen's Association on October 12, Mr. Wm. Mayer dealt with the rise and progress of ironfounding and his own fifty years' experience in the foundry. Abstracts of the address are given herewith:—

The present prominence of cast iron would almost lead us to believe that there had never been any dearth or want of cast iron in this country, but an Act passed in 1535 by the Scottish Parliament, in the reign of James V., proves that cast iron was not being made in Scotland at that date. By the Act it was ordained that every landed man should have a hagbut of cast iron together with the mould, bullets, and pellocks of lead or iron and with the powder convenient thereto, for every £100 of land that he owned; he that had but 100 marks of land was to supply two culverins, whilst only one was required of the small landowner whose valuation did not exceed £40. These pieces were to be furnished with all the necessary accessories. Those who supplied the weapons were also called upon to provide the men, not only to fire them, but also to teach others to do so. Neither the clergy nor even women were exempted from the general obligation, and because neither artillery nor harness could be furnished unless the same were imported into the country, every merchant sailing forth of the Realm and exporting goods amounting to a last (12 tons), was required to bring home two hagbuts or more in proportion to the quantity of merchandise shipped, or in place of these, as much metal as would make them. That indicates there was no iron trade of note in Scotland about the middle of the sixteenth century, though they could at that time mould and cast these hagbuts and culverins for defensive purposes with imported metal.

There were many attempts to make pig-iron in Scotland, which generally came to failure, chiefly owing to the want of motive power and wood to make charcoal which was the fuel used for smelting. At that time, and right up to the middle of the eighteenth century, there was a great dearth and scarcity of both malleable and cast iron, and it was not until the first day of 1760 that the Carron Company blew in their first blast furnace, when the making of pig-iron was proved and established in Scotland as a commercial success.

Coming to my own earliest experiences in the foundry, I distinctly remember how an open mould, especially with cores in it, attracted and puzzled me, and it was some time before I got a thorough grasp of the construction of the mould with its peculiar forms and twists; and I am of the firm opinion that 90 per cent. or more of the people to-day who have no connection with the foundry trade, have no knowledge as to what it really is, and what it is doing for them generally, but mostly give the credit of what we do and make to others, generally to the engineer. The foundry where I first learned the rudiments of the trade and to work will rank as one of the oldest in the country, and had been established in connection with a colliery plant to make all sorts of colliery castings. In the pattern loft there were some very old and peculiar patterns, including the patterns for rails for tramways and railways, with a fish-bellied bottom. There were no lights in this foundry other than the hand lamps which burned a sort of coal-tar oil. The metal was all carried in shank ladles, and in the winter the only light was that from a ball of shavings rolled up and thrown on the top of the ladle to give light in carrying the metal from the cupola to the moulds to to be cast. The castings made were mostly wheels for colliery tubs or hutches, and in all cases they were bedded in or moulded in the foundry floor.

There were no labourers in that foundry, so that the moulders had everything to do for themselves and amongst themselves, even to carrying all the castings they made to the fettling or dressing place (it could not be called a department). The moulders tapped and stopped or botted up the cupola. The method of tapping was with a long iron bar with a tapered round point, which was driven into the tapping hole by being held with one hand while a swinging blow was given by a tapping hammer with the other hand; and the tapping hole often resembled a swallow's nest with the flakes and patches of clay round about it, as there was then no mixing of a little coal dust in the clay or putting a piece of coal in the end of the bot.

Metal then was mostly of the cold-blast kind, and its qualities for some purposes were judged by the number of blows required to break it with a pig-breaking hammer and how far it bent before breaking. For other special purposes, such as chilling, it was judged by the colour grain and fracture. At that time chilled wheels were quite a speciality, and it required skill, judgment, and commonsense knowledge in the selection of the most suitable metals for that purpose. Cast-iron chilled wheels were very largely used for railway wagons carrying mineral traffic and such like, but while they answered the purpose in a way, were never a complete success, owing to the design and formation of the wheels. Then, as is often done now, the laws of contraction and expansion were ignored; the wheels were below and above 3 ft. in diameter, full of flat spokes the same depth as the rim of the wheel, sometimes with a feather on each side at the moulding top or inside of the wheel, with the spokes all in line like the wooden wheel which we are so conversant with to-day, with a large square hole in the boss. Provision for contraction had to be made by splitting the boss of the wheel in four places at the four corners of the square hole with malleable iron keys coated with clay wash and blacking, which dropped out after the casting was cold, and the chilled rim of the wheel had drawn the spokes to it in contraction. Then before the wheel was wedged on to the axle with wood packing pieces and iron wedges, the key holes were filled up with iron wedges and an iron hoop put on the boss on each side of the wheel. Evidently the wooden age had got such a hold that the idea never occurred to them to put an odd arm or spoke into the wheel, and thus break up the direct line of contraction.

There is undeniable evidence that the first building of iron bridges was done in cast iron. There is Sunderland bridge—one of the very earliest examples of a cast-iron bridge—with its one bold arch still in existence, carrying its increased burdens year by year. There is also that first example of a cast-iron bridge in the world—the high-level bridge across the Tyne at Newcastle-on-Tyne—with its two storeys or departments, the bottom one for foot passengers and all sorts of wheeled traffic, and the top one carrying the immense and ever-increasing railway traffic.

An important industry, in fact, the very backbone of the country, that the foundrymen has benefited

beyond conception, is the agricultural industry, in which the foundry has met all demands by making castings for the many and various machines for doing everything in tilling the land and farming. Coming now to shipbuilding and the various kinds of engines employed for marine work, the compound engine with a high- and low-pressure cylinder, was the one which gave me my starting experience in marine-engine castings; but to-day we have the three-cylinder triple-expansion engine in almost universal use, and its introduction was the outcome of the boilermaker being able to make boilers that would stand greater steam pressures. The foundryman has had to follow in making cylinders and other castings for this type of engine; castings that will stand a water-testing pressure to a factor of safety above the boiler pressure, whereby the risks are very considerably increased in the foundry as compared with the days of even the compound engine. Among the troubles of the foundryman may be classed the greedy design where a part of an engine is made to answer a double purpose. The most glaring case is the marine cast-iron condenser with the cylinder supporting columns generally cast in to it. Just at the present time, however, they are out of favour as a main part of the engine; but the anxieties and heartaches that the making of this class of casting has given the foundryman will never be told. When it was erected in its place, set to work, and fairly heated with the exhaust steam from the low-pressure cylinder going down the exhaust column, expansion was set up on the large cast-iron box condenser and exhaust column, a growth in the cast-iron forming the back or the condenser side of the engine occurred, while the columns on the front side of the engine were only carrying the cylinders and were practically cold and rigid. Can there be any wonder at the frequent cracking of condensers and cylinders at sea, and propeller shafts being forced out of line? Many a time the foundryman has been blamed for these cracks and their accompanying disasters, though he was entirely blameless.

Another source of trouble to the foundry was a method that was in vogue of making cast-iron propellers. In this method four straight angles were set, not circled to the diameter of the propeller required, but just tapered to the pitch required, with a centre line on them which was placed on the centre line on the bed with the two ends standing out at another diameter altogether. When the system of measuring the pitch of propellers came into vogue it was found out that propellers made this way were of no pitch at all, as the only part that was right was the centre line on the blade: but the foundryman was blamed and charged with being very careless, regardless of the fact that the trouble would always be there so long as they were made by that method. Whoever it may be who introduced the separate or independent condenser, we foundrymen owe him a debt of gratitude, and the marine-engine builder owes him a still deeper debt of gratitude. At the present day we have the quadruple engine, various kinds of turbine engines, and the oil-driven engine, all past the experimental stage, that have brought their no small share of risks and trouble to the foundryman, and although the art of making all these important castings has not been reduced to an exact science, and will never be, we have succeeded in making all we have been called upon to make. The same remark applies equally to all other classes of ironfounding.

A glance at the apparatus employed in any industry will reveal many of the important parts as being made in the foundry, and will show what part we are playing in the world's progress; and even though the trade is often looked upon with scorn and spoken of in sarcasm, it is only because those that do so are ignorant and have no knowledge of the importance of the foundry. It is the foundryman's imperative duty to live himself up and live these unwarrantable prejudices down, so that in future we may attract the best of apprentices both in body and brain to the trade.

As to the future of ironfounding, we can only hazard a conjecture. The first great change will probably be to the melting of metal by electricity in a way that will pay in competition with the old method. To melt by electricity is very desirable, because by that system there would be no coke used, and the troubles associated with it would be avoided. It is a truism that no metal or pig-iron could be made so good but that a coke could be found that would be bad enough to spoil it. When this desirable change is brought about it is only reasonable to infer that the makers of pig-iron will use the same power for making the iron, and so do away with the use of a lot of high-sulphur fuels that are used at present for making pig-iron. Further, we may look for a system or an apparatus for exhausting the air and steam out of moulds before casting, and in the case of large moulds of drawing the gases and air out right up to the time the mould is full.

There may also in the future be discovered a method of making cast-iron so malleable that it will stretch and bend a little before cracking, will run fluid, and be easily melted. The next probable important thing that will have to be dealt with is the standardising of marine and other engines and machines, so that for cylinders and other large castings the moulds would be made in parts in pattern moulds and core-boxes, and be fitted together in the casting pit on the same principle employed for moulds in which plaster of Paris and composition figures are cast. In many cases a quantity of the parts of both moulds and cores could be made by moulding machines. A similar system has been worked in America for some time. The parts of moulds by this system are being made continuously and put together and cast the same continuous way in casting frames or pits.

In conclusion, there is much to be done in establishing a correct system of education for those that are going to make a profession of designing steam and other engines and machines made in cast metals, the basis of their education being a thorough knowledge of the laws of contraction and expansion, and a knowledge of the limit that cast-iron will do and stand up to in steam cylinders. On comparing the steam pressures of the old days of 35 lbs., 60 lbs., and 80 lbs. with the pressures that are in use to-day, it is marvellous that cylinders made the way they are made with cast-iron stand such pressures compared to the boilers and the way they are made with mild steel.

A New Iron Cement.

Messrs. W. T. Hawkins & Company, Chapel Hill, Huddersfield, have placed on the market a very useful iron cement for repairing blemishes on castings which would otherwise have to be scrapped on account of bad appearance only. This cement is a chemically prepared iron compound which, on being mixed with water into a stiff putty, sets up a chemical action, and causes the material to set perfectly hard in 12 hours. It becomes part of the casting to which it is applied, so that an expert could not detect it. It can be burnished and buffed, and can be worked the same as the metal. It has the same colour as cast iron, which makes it of great value for filling up blow holes, etc., in castings generally. It has, further, the same expansion and contraction as iron.

Progress of Work on Boronised Copper.*

By Dr. E. Weintraub.†

The process of boronising copper was merely the result of a lucky idea which forced itself upon the writer through experimentation in a totally different line, namely, that of preparing the element boron in a pure state. After having isolated the element boron the writer was struck by the great affinity displayed by it toward practically every known element, whether metalloid or metal, but was no less impressed by the apparent lack of affinity between boron and copper even at the melting point of the latter.

It had often been observed that it was difficult to produce cast copper mechanically sound and of high electrical conductivity; and it was thought by the writer that since boron has such a high affinity for oxygen, nitrogen, and oxygen-containing gases, which were probably, in one way or another, the cause of the difficulties in copper casting, and as boron on the other hand apparently had no affinity for copper, it was very probable that boron would be the natural deoxidiser for copper. On the experiment of adding about 0.1 per cent. of amorphous boron (boron suboxide) to copper, a sample bar was produced which looked good, and measured up to 94 per cent. conductivity of Matthiessen standard.

Every simplification and every new idea that occurred was tried, and the results did nothing but confirm the theory. The first simplification consisted in the substitution of boron suboxide flux for boron suboxide. Boron suboxide is made by reducing boric anhydride with magnesium, aluminium, or an alkali metal, and chemical treatment of the reaction product. For copper casting it is, however, unnecessary to treat the product, as the ingredients of it (excess of boric anhydride and of borate) outside of boron suboxide are harmless or even useful in diluting the active agent. Of this boron suboxide flux 0.75 to 1 per cent. has to be added (equivalent to 0.08 to 0.1 per cent. of boron suboxide). This is the flux at present used. However, any material which contains boron in a state of oxidation below that of boric anhydride is a flux for copper casting. Among other compounds of boron which satisfy this condition may be mentioned boron carbide or any alloy of carbon and boron. In order to better make the boron react on the gases in the copper, it was thought best to superheat the copper, this in spite of the contention that the copper would "burn." The result was satisfactory.

After the process had been made to work, many directions presented themselves for further investigation. First, and perhaps the most important, from the point of view of pure investigation, was the question of what the boron flux actually does. The writer has no reason to doubt that the boron reduces some gas in the copper which is either oxygen itself or contains oxygen. Another line was to study the deoxidation of copper alloys by boron. A little has been done on these lines, and it has been ascertained that all the copper alloys containing the elements zinc, tin, lead, greatly benefit by being deoxidised by boron.

The direction of the experiments was influenced by the fact that the process has been developed in an electrical company. The question was, what could be done with the process, what electrical apparatus could be cast thereby to either save money or improve the product. But the industry had developed all sorts of ingenious ways of working copper, of drawing, punching, drop forging, etc., to avoid casting the metal, until the methods got so perfected that when means had been found for casting copper there was, at first, hardly a place where it was thought to be needed. However, by this time we have got quite a distance toward replacing forged copper by cast copper, and a large number of castings are made at present. Meter fields, coils of current transformers, transformer terminals, series coils for interpoles, blow-out coils, large current switchblades, contact studs, secondaries of welding transformers, clamps of welding transformers, etc., are now being regularly cast in boronised copper. Last, but not least, may be mentioned the success attained in casting the rotors of induction motors, either casting the short-circuiting ring around the forged bars or casting the whole armature. Some of these apparatus are cast in sand moulds, and some, of simpler shape and used in large numbers, are cast in iron moulds. To the latter class belong, among others, switchblades and meter fields.

The advantages derived from the substitution of cast copper for forged copper are not only the saving in cost. In most cases, also, a better apparatus is obtained. It is possible in casting to eliminate a number of joints, which are always a source of loss in efficiency. In the case of current transformers, for instance, not only a better apparatus is obtained at a reduced cost, but also space is saved. It is considerations like these, saving of money or space, or improvement of the quality of the apparatus, that have moved the engineers to replace forged copper by cast copper in every case they have done so.

It now remains for the writer to give some details of how the process of boronising copper is carried out, and what precautions are to be taken in order to secure a good casting. The boron suboxide flux can be added to the copper in different ways which are equally good. In the Lynn Foundry the pots contain about 125 lbs. of metal, and up to the present coal furnaces have been used. The method used consists in mixing half of the boron flux to be added with charcoal, putting it on the bottom of the pot and melting the copper down. When the copper has reached the necessary temperature (the copper may be heated too low but not too high), the pot is taken out, the slag skimmed off, and the second half of the boron flux added and thoroughly stirred in. After a minute or so the slag comes up to the surface in the form of fused lumps and is skimmed off, and the melt is cooled down by adding gates or risers until the proper pouring temperature is obtained.

In case a reverberatory furnace is used, as in Schenectady, the procedure usually followed is to put the flux in the ladle pot on the bottom, pour the copper over it and stir thoroughly. The skimmer and stirrer are preferably not of iron, since it is difficult to avoid a solution of a slight amount of iron in the copper, and a resulting lowering of conductivity. If done very carefully the amount of iron would probably be very small, but it has not been found practicable to trust the foundrymen with an iron

* Paper presented at the Annual Meeting of the American Institute of Metals, September, 1912.

† West Lynn Research Laboratory; General Electric Co.

skimmer or stirrer. Heavy graphite stirrers and skimmers have proven suitable, and are being constantly used.

The boronising process delivers a good metal, and the production of a good casting depends now on the same factors as in other metals. The copper shrinks considerably, about ¼ in. to the foot, and this must be taken into consideration. The casting must be well fed, and the sand mould must be rammed only very lightly. In case of iron moulds the iron must, of course, be covered with soot, and in some cases it is found desirable to use a graphite plate where the hot metal first strikes. In the case of induction rotors it is necessary to overcome difficulties due to the shrinking and cracking of the different parts of the copper casting. When these precautions are taken no more difficulty is experienced in casting copper than in casting ordinary brass.

The electrical conductivity obtained can be as high as 97 per cent. of the Matthiessen standard, but in the foundry using scrap, which is not always as clean as could be desired, it is not found feasible to guarantee more than 90 per cent. conductivity. The mechanical properties are as follows:—

Tensile strength.	Elastic limit.	Elong.	Red. in arc
24,350 lbs. per sq. in.	11,450 lbs. per sq. in.	48.5%	74.49%
17·0 kg. per sq. mm.	8.0 kg. per sq. mm.		

Rapid Estimation of Carbon in the Foundry.

By Cuthbert H. Blenkinsop.

A rapid method of estimating the percentage of carbon in samples of steel is sure to appeal to every practical foundryman, for it is very desirable for him to have an idea of the composition of the steel he is working with, independent of the laboratory. Chemical tests to the busy foundryman are a nuisance, and no matter how quickly they can be done they take up too much valuable time. In addition to this, very few foundrymen have the room and facilities for carrying out chemical tests.

Estimations by fracture are not always to be relied on and, unless one knows the history of the piece of steel in regard to its treatment after being cast, fractures are very deceiving. For instance, before breaking a "bath" sample it is generally cooled gradually with a good slag on, and is nearly always hammered out before being broken. The result is, in the case of mild steel, a beautiful fibrous fracture. But a piece knocked off a casting in this material would give a granular coarse-looking fracture, more especially in the unannealed state.

Again, such additions as aluminium tend to alter the grain of the fracture and so make the estimation of carbon by fracture more complex. Apart from all this, drilling a casting is to obtain drillings for a chemical determination is not always convenient, and on the other hand, it is not always convenient to break a casting so as to get a suitable fracture for the estimation of carbon.

A rapid test which the writer proposes to describe, is a mechanical one—that of grinding a piece of steel on a carborundum, emery or electrite wheel. The sparks given off when steels of different carbon contents are ground vary very much indeed, and it is in the appearance of these sparks that the test is found. The writer's attention was drawn to the matter some time ago, and he has since followed the subject very closely. Indeed so accurate and reliable has this test become with a little practice, that the writer uses it practically every day in practical steel manufacturing, and now furnace samples are passed off in this way in addition to many other things. It is found to be most useful between 0.10 per cent. and 0.35 per cent., or 0.40 per cent. of carbon.

There are, roughly speaking, two classes of sparks —"blobs" and "stars." The blobs are found with milder steels, and the stars with harder. When a piece of mild steel is put on the stone, blobs are given off, and on a careful observation these blobs are found to form on the end of a thin streak of what might be called fire. Between 0.06 per cent. and about 0.10 per cent. the blob and the streak are as bright as each other, but above that percentage they differ. As the percentage of carbon increases the blobs get considerably brighter than the streaks, so that between 0.14 per cent. and 0.18 per cent. carbon bright blobs and dull streaks are formed. Above 0.18 per cent. the blobs are intermingled with stars or exploding blobs. These stars are of two classes—stars on the end of streaks and stars which form independent of streaks. From about 0.19 per cent. to 0.23 per cent. are got stars and blobs mixed and also streaks. The stars, however, are found outside the radius of the blobs as a rule. From 0.24 per cent. to 0.30 per cent. carbon the blobs become very scarce, and the streaks are very dull with good bright exploding stars. Stars obtained with these percentages of carbon can be called fat stars, as they differ greatly in construction to stars obtained with higher percentages. Above 0.30 per cent. carbon the blobs begin to disappear quickly, and the stars begin to change into thin stars. Above 0.35 per cent. carbon the stars form a good distance from the wheel independent of streaks, and as the carbon increases the segments of these stars become thinner and the star becomes duller.

Foundrymen, when sending samples to the laboratory will find it convenient to either keep a duplicate sample or grind the sample before sending it, noting the construction of the sparks and comparing them with the percentage of carbon, till familiarity with the carborundum test is attained. In conclusion the writer may say that he taught an ordinary moulder this method so well in one week, that out of seventeen samples submitted to him for testing by the stone test, fifteen were within 0.01 of the result obtained by chemistry. One word of warning is necessary. Never use drillings off a surface which has been ground by a carborundum, emery or electrite wheel for a chemical estimation of carbon, as the result will be much higher than it should be.

A New Aluminium Alloy.

Under the name of "Navaltum," a new alloy of aluminium has recently been brought out, and it is suggested that it may play an important part in the future manufacture of machinery and of motor car parts. A novel process is stated to bring about changes in ordinary aluminium analagous to those which are effected in the conversion of iron into steel. The results of experiments with the new metal prove, it is claimed, that it possesses greater strength than gunmetal, while it is as ductile as malleable iron. In tensile strength it resembles mild steel, while the specific gravity is as low as 2.6.

As a result of tests which the South Indian Railway Company has carried out with a few cast-iron sleepers manufactured at the Barakur Iron Works of the Bengal Iron and Steel Company, Limited, the Railway Company has placed further trial orders with the Barakur Works on a more extended scale—for about 100 tons of broad-gauge and 100 tons of meter-gauge cast-iron sleepers—to be tested at the place of manufacture.

Shelves for the Storage of Patterns.

Patterns of medium and small size are always stored on shelves. A building used for this purpose, whether it be large or small, built specially as a pattern stores or converted to the purpose, always has to be fitted with shelves throughout, not only around its walls, but in avenues across its floors. It is only in this way that space can be properly utilised. As most of the shelves have to be erected quite independently of the walls, the constructions shown in Figs. 1 and 2 are characteristic of pattern

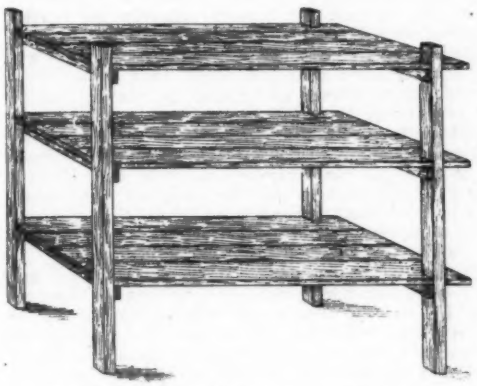


FIG. 1.—SHELVES SUPPORTED AT EDGES.

stores. Numbers of vertical posts are necessary to which horizontal pieces to support the shelf boards are attached. These posts should be placed over joists of the floor below, and their tops are usually secured to the sides of joists above.

The construction shown in Fig. 1 is the strongest and simplest. Only four posts are shown, but the number depends on the length of the shelves, posts being required at distances of about 6 ft. Generally the shelves are arranged so that they are accessible

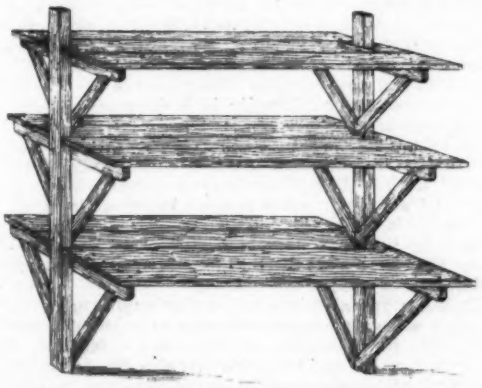


FIG. 2.—SHELVES SUPPORTED IN THE MIDDLE.

from both sides, and in such cases their width should not be less than 3 ft., though it may be an advantage to make the upper ones narrower. The construction is very simple, as will be seen in Fig. 1. The shelf boards rest on cross pieces which are nailed or screwed securely to the uprights. The outer boards are notched to fit round the uprights, and a few small nails are used to keep the boards in place on the cross pieces. The uprights may be secured in place on the floor by skew nails, blocks, or iron brackets. This attachment is mainly to keep it in a fixed position and adds scarcely anything to the stability of the structure.

In Fig. 2 single uprights are used in the middle of the shelves and diagonal braces help to support and keep the cross pieces horizontal. This method is rather more troublesome than the previous one, but it leaves the edges of the shelves clear of posts, which are more or less in the way, and help to obstruct light. The cross-pieces and braces may go against the sides of the uprights, as shown. Sometimes they

FIG. 3.—LOOSE BAR FOR KEEPING SMALL PATTERNS SEPARATE.

are made more rigid by rebating them a little way in. In any case the braces must fit against the under edges of the cross-pieces, and should be notched into them slightly, so that the parts shall not depend entirely on the nails which keep them together. At the lowest ends of the braces it may be sufficient to nail well to the posts, but it is better there also if the ends have something below to bear on, either blocks or the cross-pieces of the shelves below. When built in this style the upper shelves are generally made narrower than the lower ones. Usually three tiers, as shown, are the most that can be arranged between a floor and ceiling. The lowest should be about 3 ft. above the floor, and the space beneath it is also used for storage. With single central uprights, as in Fig. 2, secure attachment to floor and ceiling is essential.

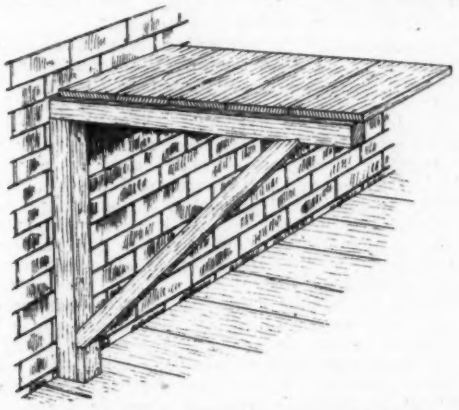


FIG. 4.—SHELF FITTED AGAINST WALL.

Sets of patterns or patterns alike in character, often have to be kept together, and some means of partitioning off is a convenience, especially if the patterns are small and numerous. A handy means

of doing this is by having a number of loose bars like that shown in Fig. 3. The bar's length corresponds with the width of the shelves and in section it may measure ½ in. by 2 in., or more.

Broad wall shelves may be supported by large brackets, as shown in Fig. 4. Another way is to construct as in Fig. 1, but generally bracketed shelves are used against walls, and the shelves are narrow compared with the independent two-sided ones illustrated in Figs. 1 and 2. A lower shelf, as in Fig. 4, may be as much as 2 ft. 6 in. in width, but upper ones should be considerably less. Walls with windows should not have upper shelves except in places where no light is obstructed thereby.

Autogenous Welding of Copper and its Principal Alloys, and of Aluminium.*

By Dr. F. Carnevali (Royal Polytechnic School, Turin).

Supplementary to a series of investigations concerning the oxy-acetylene autogenous welding of iron and steel, which the author carried out and dealt with in a Paper presented at the October, 1911, meeting of the Iron and Steel Institute, he has undertaken the study of the oxy-acetylene welding of various metals other than iron and steel, and now submits an account of the results on (1) copper and its principal alloys (brass and bronze), and (2) aluminium. His conclusions are as follows:

Copper and its Chief Alloys.—(1) Rapid heating and sudden fusion of the metal subjected to welding profoundly modify its physical and mechanical properties, developing within it internal strains and structural alterations which are of detrimental effect.

(2) The structural modifications which take place in the process of welding, apart from the alterations in composition of the metal, may be classified under two principal headings: (i) coarse crystallisation of a single-constituent metal, and (ii) minutely heterogeneous structure of an alloy consisting of two or more elements. The discontinuity of structure attaching to metals in which there are oxide inclusions or vacuoles must be taken into account.

(3) The deficiency in mechanical properties, most conspicuous in all that regards the tenacity and elasticity of a metal, is expressed in the case of copper by an average reduction of 50 per cent. in the capacity to resist fracture, and an increase of about 30 per cent. in brittleness, while the percentage ductility is reduced to about a tenth of the original. In the case of bronzes and brasses, the deficiency in mechanical properties is not susceptible of rigorous mensuration, but it is greatly intensified and proportionately detrimental as the number and variety of the constituents of the alloy subjected to welding are increased.

(4) While mechanical treatment, such as hammering along the zone of welding, has practically no useful effect on the properties of the welded metal, thermal treatment, such as reheating, prolonged for a suitable interval at a fixed temperature, exerts an undoubted ameliorative influence, since in the first place it relieves the latent internal strain set up by the sudden temperature-changes involved in the process of welding, and in the second place it restores homogeneity to the structure of the metal itself. Consequently, and more particularly in the case of alloys made up of several constituents, the conditions of cooling of the welded metal are of special importance, the slower the cooling the greater being the ameliorative effect.

(5) Considerable variations—diverse according to the manner in which the process of welding is applied—occur in the composition of bronzes and brasses; these variations are the more extensive the greater is the number of constituents of which the alloy is made up, and also in proportion to the affinity of these constituents for oxygen and to the volatility of the oxides formed therefrom. Thus, for example, in certain bronzes, in the welded zone there is an average diminution of 19.0 per cent. in the proportion of tin; while the loss of zinc, a more easily oxidised metal than tin, amounts to 22.3 per cent. (the original proportion present being smaller than that of tin). In brasses, wherein the percentage of zinc is much higher, its decrease in the welded zone amounts to 28.7 per cent. It must also be borne in mind that the oxides thus formed have a tendency to diffuse easily into the metal, modifying profoundly its properties. In pure copper subjected to the welding process, changes in chemical composition cannot be traced, as the metal is made up of a single constituent; and it is only affected deeply by oxidation when the necessary precautions have been omitted in the process of welding, the suboxide then formed diffusing with great facility into the copper.

(6) Taking into account the results obtained and the conclusions here postulated, it may be asserted that the oxy-acetylene autogenous welding of copper and its principal alloys has a practical application, limited to those parts of machinery which are not of large dimensions and are not subjected to severe mechanical stresses.

Aluminium.—(1) Sudden heating and rapid fusion of the metal subjected to the welding process alter its physical and mechanical properties in a manner analogous to that observed in the case of copper, though in less degree. They set up within the metal latent internal strains, and modify its structure detrimentally.

(2) The structural modifications induced by excessively rapid heating during the process of welding, take the form of coarse crystallisation of the metal.

(3) So long as all the necessary precautions are observed in the process of welding, the changes in the mechanical properties of pure aluminium, such as breaking strain, ductility, hardness of the weld-zone, are not very profound, although a notable increase in brittleness is observable, as is shown by the results of shock tests. The presence of copper, however, modifies profoundly in a detrimental sense the mechanical properties of aluminium.

(4) In consequence of the feasibility of achieving with pure aluminium a perfect and homogeneous weld of the metal, both mechanical (hammering) and thermal (reheating to 450 degrees to 500 degrees C.) treatment is extremely efficacious, in that it sets up greater homogeneity in the weld-zone, and eliminates the effect of the excessively rapid heating undergone in process of welding.

(5) Whenever aluminium contains small quantities of other elements easily oxidisable at high temperatures (as, for example, copper), the oxidation of the metal in fusion is facilitated, also the inclusion within it of granules of oxide detrimental to the mechanical properties of the weld-zone.

(6) Taking into account the results obtained, as also the foregoing conclusions, it may be asserted that the oxy-acetylene autogenous welding of aluminium, when carried out with the necessary precautions, is capable of extensive application in practice, especially for the autogenous welding of small machine parts.

* Abstract of Paper presented before the Institute of Metals September, 1912.

The Joining of Metals.*

By Alex. E. Tucker, F.I.C. (Birmingham).

The methods in practical use for joining metals may be summarised in the order of their importance as follows :—

(1). By metallic cements, such as tinman's or brazing solder, which have to be brought to the plastic or liquid state, and whose constituents should be capable of alloying perfectly with the metals to be joined.

(2). By autogenous fusing, in which the two parts are heated and liquid metal of the same character run round the mass, or the parts are heated to fusing point, and the surfaces worked together by pressure or hammering.

(3). By the use of a cementing metal under pressure, generally that of a rolling-mill, and at ordinary or only slightly raised temperatures.

Metallic Cements.

In respect to the first method, it is obvious that the fusion point of the solder must be lower than that of the articles to be joined, and as, speaking generally, the higher the melting point the stronger the solder, it follows that it is desirable that such solder or brazing spelter should be used, whenever possible, the melting point of which is only a few degrees less than that of the metals to be joined. The solder should also have, if possible, the same characteristics, such as malleability, colour, and hardness.

Tinman's Solder.—In the use of this care should be especially taken to avoid the presence of zinc, and in certain cases even a trace of zinc is especially prejudicial; it thickens the solder, and probably on account of its liability to oxidation forms a superficial scum which the ordinary spirits of salt is incapable of dissolving. If the presence of zinc be suspected, the addition of a few drops of acid will help greatly. Antimony is frequently present in tinman's solder; this, by forming a cement of higher tensile strength, may, under special conditions, make a joint of greater strength. In the use of solder, either soft solder or brazing solder, it is clearly the correct method to raise the work to the highest temperature that the solder and the work will stand, because under such conditions the penetration of the solder into the surfaces to be joined will be better, and further, the soldering medium may then be squeezed out to the maximum from between the surfaces by suitable means, and hence the requirement can be met, that the thinner the layer of cementing material and the closer the surfaces are together, the stronger the join. Additional strength, because of the additional intimacy effected, may be given to the work by rubbing the surfaces carrying the liquid solder together; in the same way it is always well to rub the soldering iron, when possible, over the work when it is used, the "wetting" of the surfaces is then more perfect, and no stripping of the solder is possible when this rubbing is done. In order to obtain a lower melting point in tin solder, bismuth, and sometimes cadmium, is added.

Many forms of soldering bits are now in use in which a bunsen-burner, connected with a light flexible tube, is employed to heat the bit, and the flame can be conveniently made to heat the work as well. This form of soldering iron has many advantages. One of the best fluxes for ordinary soldering can be easily made by macerating flux skimmings from galvanising pots with weak hydrochloric acid. On filtering, the solution is ready for use, and is an ideal flux, because of the chloride of ammonia present with the chloride of zinc. No iron or lead is dissolved if the acid added is not in excess. Solder is often used in the form of granules or strips of various sizes, and in this form is very convenient for routine work.

Brazing Solder.—The composition of ordinary brazing solder ranges within wide limits. The higher the percentage of copper the higher the melting point, and the higher the percentage of tin the lighter the colour. The presence of other metals when in small amounts is often of no consequence in the brazing of brass or copper, though obviously in all cases it is very desirable in important work, such as the brazing of high-pressure steam-pipes or where great strength is required, that the composition of the brazing metal shall approach as closely as possible to that of the metal to be joined, as only under such conditions can the maximum strength of the joint be obtained, and it is the non-observance of these conditions which has led to disaster. The skill of the workman is often limited to the fluxing of the solder, and seldom extends to an appreciation of its composition.

When, however, we come to brazing iron and steel the importance of purity is very much greater, and the presence of tin in brazing solder has been found to be very injurious. The explanation is probably to be found in the extraordinary deleterious effect of tin on iron and steel. It is well known that a very small amount of tin scrap, if allowed to get into a bath of molten steel, will make it very red-short, and when brazing solder containing as little as 0.5 per cent. of tin is used for brazing bicycle frames, for instance, it is found that the joints are very unsatisfactory and unsafe.

An ingenious method of making a brazed joint is by connecting the two parts to be joined with the terminals of a suitable dynamo. On account of the local resistance the two parts become heated, and if suitable brass wire is wrapped round the tube, in the case of a cycle frame, and the whole surrounded with a reducing gas, such as hydrogen or coal gas, a very effective joint is obtained without any borax or other fluxing medium. The reducing gas under such conditions will ensure the absence of any oxide of iron or other metal used, and no previous cleaning is required. Such methods of joining have the great advantage that there is no borax to remove from the joint.

A modification of brazing is the use of copper in the form of sheet or wire. Under the Simpson patents tools are thus made in which the cutting part is a small piece of high-speed or other steel, while the shank is mild steel or iron. In making, say, a lathe tool by this process, a bar of square mild steel is taken, and a channel planed or milled out on it in which a suitable square piece of high-speed steel fits. The two or three sides being clean, strips of copper are fitted in with a special flux, and the whole highly heated to the fusing point of the copper. After welding, the compound tool is cleaned up and treated for hardening and tempering in the ordinary way.

* Abstract of Paper read at the annual meeting of the Institute of Metals.

If ordinary brazing were used, the hardening of many tools implies such a temperature as would often destroy an ordinary brazed point. The zinc would possibly be volatilised, which is not the case when copper alone is used, the temperature of fusion of the copper being so much higher. Secondly, it is conceivable that the weld would be considerably stronger than with an alloy of zinc, because while copper alloys to a considerable extent with iron, the same cannot be said of zinc, which, therefore, under such circumstances, would become a deteriorating element. Thirdly, the saving of expensive material, such as alloy steel, must be considerable in the case of heavy machine tools, as only a small portion of metal is ever in actual use.

The Brazing of Cast Iron.

A process has been invented by F. Pich (Berlin) for the hard brazing of cast iron in a smith's hearth. The patent consists in the decarburisation during brazing of the cast-iron surfaces to be united, and in bringing at the same time the molten brass solder into close contact with the cast-iron surfaces which are decarburised, but without exposure to the air. For the decarburisation of the surfaces copper oxide is used, which is mixed with borax as a flux, until it has the consistency of a paste. This is applied to the surfaces to be joined, which must first be carefully cleaned. The cast-iron pieces are then firmly tied together with wire and heated. The borax first melts, protecting the surfaces from oxidation, and taking up any oxide that may be still clinging to them. It also precludes the attacking of the copper oxide by the oxygen of the air. As the heating proceeds the copper oxide fuses and gives up to the now red-hot surfaces its oxygen, which combines with the graphite of the cast iron forming carbon monoxide and dioxide, while the metallic copper is set free in a very finely divided state. This alloys with the brass solder as it melts when strewn on, and the new alloy combines with the decarburised iron of the surfaces which it is desired to join. Specimens of cast iron united by this method were prepared and subjected to tensile and breaking tests, and the summary of all the results shows that when the brazing of cast-iron pieces is carefully performed according to the details given by Pich, the strength of the pieces so joined is virtually equal to that of the solid material.

The Soldering of Aluminium.

Numerous patents have been taken out, and numerous mysterious mixtures advertised, for the so-called soldering of aluminium. In nearly every case the result is that, while fairly satisfactory for a short time, the join fails after a time, varying from a few days to some months. One of the most severe tests to which such joins in aluminium can be subjected is that of warm steam. Joins which look well and are apparently mechanically strong, fail rapidly when submitted to this test. In all soldering, it is obvious that the flux used must efficiently clean the surfaces of the metals to be joined, otherwise no alloying of the solder used with the surfaces is possible. In the case of aluminium very few materials adapted for such fluxes are available, the requirement being that they shall absorb oxide of aluminium. Another detail of importance is the great heat conductivity of the metal. A consideration of the results obtained with all the so-called solders of aluminium shows that the metal is so susceptible to electrical action and oxidation, that the use of any metal in which aluminium itself does not preponderate is hopeless. The best results have invariably been obtained when the solder was of the same composition as the material to be joined. This condition involves the principle of autogenous soldering. The best flux used is a mixture of alkaline aluminium chloride, with the addition of fluorides, such as potassium fluoride or calcium fluoride. When these are mixed in suitable proportions, damped with alcohol, and heated on a strip of aluminium, the surface of the metal is cleaned perfectly. It therefore follows that if two surfaces of aluminium are so cleaned, and an alloy containing a high percentage of aluminium, with such addition of other melted metal as will reduce its melting point slightly below that of pure aluminium, applied with the flux named, a very satisfactory join will be obtained. The heat such as from a spirit-lamp or bunsen-burner must, however, be applied from below the work. The author has seen such joins made over a spirit-lamp which stood every test, including that of the steam test.

Autogenous Welding.

The application of autogenous welding by acetylene, hydrogen, benzol, petrol, or other hydrocarbon vapour to commercial purposes has extended enormously during the past few years, and constructions and work are now possible by the use of such methods, which could not be carried out by any other means; thus, repair work of ferrous and non-ferrous metals is now done in every town of importance, and tubes of all sizes are made on a very large scale.

Benzol, petrol, and other hydrocarbons have been recently used in place of hydrogen and acetylene for autogenous welding, and their use would under certain conditions have advantages.

The Oxy-Acetylene Process.—The author has found that a proportion of four volumes of acetylene to five of oxygen gives much better results than the theoretical two volumes of acetylene to five of oxygen. So important is this detail that blowpipes are now generally constructed to consistently maintain a reducing flame. A characteristic of the oxy-acetylene flame is that it indicates the correct mixture, for when the acetylene is in excess a small green cap appears over the inner cone of the flame. On reducing the oxygen there is a point at which the cap disappears. The right mixture is just at this point, and the effect is so distinct that when working with acetylene the workman has no excuse for not getting the right proportion.

In welding metals other than iron, not only the melting point but the heat conductivity of the metal must be considered. Thus copper with its high conductivity and its low melting point can hardly be worked with the oxy-hydrogen flame. Indeed, for the same section as iron it requires a much more powerful oxy-acetylene flame. Brass, bronze, and indeed any metal, may be autogenously welded, and many require much less care than that necessary for aluminium.

The conditions of success which apply to all welding with acetylene or other hydrocarbons are—(1) the use of pure gases; (2) the use of a metal rod of approximately the same composition as that of the work to be joined; (3) the thorough fusion of the inside surfaces before the additional metal is applied; (4) cleanliness of the parts, and when desirable the use of suitable dioxidising and fluxing powders, such as charcoal and borax; and lastly, the use of a blowpipe capable of complete control in respect to size of flame and proportion of mixture. With extended experience in the autogenous joining of non-ferrous metals, it is to be expected that this method will replace ordinary brazing where quality of work is of the first importance.

It should be noticed that in consequence of the highly local heating action of acetylene, contraction strains are likely to be set up, which may be more serious than those occasioned when the whole work is heated and welded up in the smith's fire in the ordinary way. In the case of cast iron it is very desirable that such strains should be avoided by making the weld first and then reheating the mass as much as possible, and cooling slowly. With respect to steel it has been repeatedly shown that an acetylene or electric weld should not be hammered while the weld is being made. It is well known that cracks are likely to be made by hammering the metal at a black heat, a temperature occurring quite close to the point of fusion. The work, therefore, should be allowed to cool slowly and then raised to a high temperature in the ordinary way and not by the blowpipe; the weld can in this way be much improved both in shape and strength. A good fusion weld very seldom breaks at the point of welding—indicating, therefore, that this point is stronger than the neighbouring metal.

The Use of Aluminium Powder.—There is an interesting series of processes for the autogenous joining of metals, most of which are patented, which depend on the reducing power of aluminium. As showing the great heat obtainable when aluminium powder is used for welding, it may be mentioned that if a wrought-iron plate 1 in. thick is placed under the crucible, the liquid metal when tapped will burn a hole straight through it, leaving a fairly smooth edge. Experiments show that the heat of the molten metal approaches 3,000 deg. C., the temperature of a Siemens furnace being about 1,600 deg. C.

Arc Welding and Resistance Welding.—A third system of autogenous welding is the electric, of which two methods are in use—namely, arc welding and resistance welding. Arc welding is applied for repairing breakages and filling up flaws in castings, while resistance welding is rapidly being adopted for the working up of metal articles.

Compound Sheets.

The last system of joining metals to which the author directs attention is the one in which the surfaces are not melted, but only slightly heated. The manufacture of aluminium-copper sheets illustrates the process, and further is interesting from a metallurgical standpoint. One method is as follows. The copper sheet is pickled and cleaned. Aluminium powder is then brushed on by machinery, or by rubbing the surfaces with brushes or rollers of aluminium wire. A sheet of cleaned aluminium is then placed on such a surface, the two are heated and passed through rolls. The union is perfect, and hence the compound sheet may be subjected to stamping, spinning, etc., without any trace of lamination.

In the same way, copper and steel, or almost any number of sheets of different metals, may be compounded. The aluminium acts as a metallic adhesive. While rolling such sheets the top surfaces are often kept oiled to retard oxidation, and to obtain better finish.

A second method of making a compound sheet of different metals is that in which an oxide or sulphide of a metal which will alloy with both of the two sheets is taken and mixed with aluminium powder, and the mixture laid evenly between them. The whole is then heated to the fluxing point of the mixture and then rolled, and as the two sheets to be joined receive the full heat of the furnace in which the work is placed, it will be understood that the alloying of the metal from the mixture with the two surfaces of the sheets is complete.

In another method, where still more heat is used, for the production of compound plate, say of aluminium and copper, copper or other wire gauze is placed between the sheets, and the interstices filled as before with aluminium powder and flux, consisting of alkaline, chloride, and fluoride. On heating the whole and rolling, the surfaces unite as before described, and probably more perfectly, because the gauze retains the flux better during the heating, and so does its work better, and is afterwards squeezed out by the rolls, while in addition there would also be the knitting or dowelling action of the gauze during rolling, which would further tend to hold the sheets together.

The use of such wire gauze would seem to be applicable to certain conditions of brazing, especially when the greatest care is necessary to produce the highest quality of work.

Discussion.

Mr. F. Johnson referred to a statement in the Paper that when metal containing as little as 0.5 per cent. of tin was used for brazing bicycle frames, it was found that the joints were very unsatisfactory, and even unsafe. He (the speaker) had pointed out at the last meeting that tin in brass, particularly the compounds of tin which existed in brazing solder, separated out from the brass in the form of a brittle eutectoid, and in his opinion the brittle nature of the joint was distinctly attributable to the presence of that brittle Sn Cu_4 eutectoid.

Dr. Walter Rosenhain remarked that experiments carried out at the National Physical Laboratory with various kinds of welds on iron and steel, and also a large number of mechanical tests, had given results which were strongly in confirmation of Dr. Carnevali's contention that the process almost inevitably resulted in injury to the metal, generally not at the point of the weld but just beyond it. What really happened was that the metal became overheated in the process of welding. In some cases it might be possible to apply forging work to the metal at the weld itself, but just beyond the point where the weld had taken place—unless great precautions had been taken to thicken up the metal first and reduce it afterwards—there was an overheated structure which was dangerous. Whilst autogenous welding might be an extremely useful process for the purpose of repair and construction where gases and liquids under small pressures only had to be taken into consideration, it was a dangerous process if it was applied to parts—such as working parts of machinery—which had to carry stress.

Mr. E. I. Thorne thought the hot-water test was quite as good as, if not better than, the steam test. He had made many tests of aluminium alloys in the joining up of aluminium by this means, and he did not think there was any solder that would successfully withstand the hot-water test where the joining metal was composed largely of some other element than aluminium. The chief point, however, was as to the value of the test to the manufacturer.

The President (Professor W. Gowland), in bringing the discussion to a close, thought the use of the word "spelter," as used in Mr. Tucker's Paper, should be discouraged. In Birmingham and some other districts it was well-known that the workmen used this word when referring to brazing solder. It was purely local in its use, but when used in a Paper like this it was very liable to be confounded with spelter in its true sense, namely, zinc. Autogenous welding was sometimes spoken of as something modern, but as a matter of fact, the Romans practised it a century of two B.C. The system of burning on was also very extensively practised in Japan, where in bronze foundries the vases and ornamental objects which were cast were always cast in a very simple form, and the handles burnt on.

Cupola Practice.

By Sidney G. Smith.

The problem of melting iron quickly, cleanly and cheaply concerns all those responsible in running a foundry. Although there are many types of cupolas, each claiming superiority in some respect, it should not be forgotten that to melt in a cupola iron fit to pour a mould requires, even under the best of conditions, a definite amount of carbon, oxygen and flux, and that if this amount is not forthcoming, no matter what type of cupola is used, a hot, clean fluid iron will not follow. On the other hand, if the amount of either of these is in excess, then there is a waste going on that will tell its own tale in the costs.

With each cupola it should be ascertained by experiment what amount of carbon, blast and flux will give a clean, fluid iron, and enquiry should be made into the large number of variations in materials, conditions, etc., which affect the question, though this will necessarily occupy much time.

It is not the writer's intention to advocate any particular type of cupola; at the same time, he holds the opinion that the ordinary cupola has not yet become obsolete. But whatever the type of cupola chosen, what should be arrived at is, how to economically manipulate it and give satisfactory results.

When building a cupola, either a drop bottom or solid bottom (the choice is largely a question of taste, though the drop-bottom type has a distinct advantage over the solid-bottom type when letting out), some of the most important questions to be considered are as follows:—

What quantity of iron melted per hour, or day, is required?

Whether the cupola is for continuous, daily, part daily, or occasional melting?

Are large quantities required to be tapped at one time?

In considering these points tuyere arrangements and area of cupola is important. The area at the bosh, or bottom part of the cupola, principally decides how many tons of iron will be melted per hour. The accepted area per ton melted per hour, as quoted by Mr. R. Mason, and which is borne out in practice, is as follows:—

Diameter of cupola. Inches.	Amount per hour melted. Tons.	Cwts.
20	1	5
24	1	17
30	3	0
36	4	5
43	6	1
48	7	10
54	9	1
60	11	15
62	12	11
66	14	15

Some cupolas, owing to a variety of occurrences and conditions, may not quite come up to the figures quoted; other cupolas, owing to exceedingly favourable conditions, will exceed those figures.

The distance from the bottom of the cupola to the slag hole and tuyeres—the well or bath—will depend upon the amount of metal required to be tapped at one time. If a cupola is in daily blast and the iron run into a receiver as it melts, such as into a large ladle at the tapping spout (and there are many such cupolas, apart from the modern type with attached receivers) the slag hole and tuyeres can be arranged very low down, so near to the bottom that only the slagging off is considered. With such cupolas, which are mostly four or five feet diameter, the bed charge of coke is comparatively small, and burns quickly up to the tuyeres, ready for blast.

As a rule these cupolas are charged the previous evening, or early morning, so that the blast can be put on at 5.30 or 6 o'clock each morning. They are installed in pairs, and are put in blast alternately.

If the well of the cupola is required to hold a few tons before tapping, which is quite common in jobbing and general foundries, the position of the slagging hole and tuyeres must be raised according to the diameter of the bosh; consequently the bed charge of coke will be increased, also the time required to burn through.

Commencing with the shell of a cupola, this may be ten to twenty feet high, and from $\frac{3}{16}$ to $\frac{5}{16}$ thick (according to diameter). The breast-plate (if solid bottom), tapping holes and charging door, are cut out and strengthened; a strong flange, or angle iron, is riveted on the bottom, and a few tiers of angle iron are riveted inside to stay the lining. The tuyere arrangement having been marked off, the shell is placed in position, either on solid masonry or columns, as the case may be. The lining should be two courses, build in two, the inside course of which should be of a high-class refractory brick. When within 24 in. of the charging door, in place of bricks cast-iron hollow bricks, as shown in Fig. 2, if used, will be found economical and durable, as they resist the wear and tear of the charges coming into contact with them better than do fire bricks. The iron brick conforms to the radius of the shell, and as each course is laid on, the hollow is filled in with brick chips, mixed with ganister, or fireclay. Above the charging door, and up the stack, a lower-grade cheap fire brick may be used.

The distance from the charging door to the top of the stack is much a matter of opinion and convenience. A dust catcher at the top of the stack comprises a modern improvement, and the adoption of this is well worth considering, especially from the standpoint of cleanliness.

The arrangement, area, and shape of tuyeres, is a rather contentious matter. The writer has, during his experience, seen many weird ideas and arrangements in tuyeres and pipes, which have reached from the bottom of the cupola to the top. These have come, and gone, and owing to impractability and misconception have mostly been failures. With large or small cupolas, the writer is decidedly in favour of one row of tuyeres of sufficient number and area to supply the necessary amount of air for complete and rapid combustion. A few large tuyeres are more advantageous than many small ones. There is less resistance to the blast, and the tuyeres are more easily kept clean and clear when working. When being fettled they need not be directly in line with each other; they may, with advantage, be diverted either downwards, or alternately to right or left angles. To obtain uniform, clean and quick melting, the aim should be to circulate or distribute the blast in sufficient volume sectionally and radially, so that the whole mass underneath and in the melting zone will be in a complete state of incandescence, quite free from any cool places, which are detrimental to

good melting. Of course, there are more factors than the blast to consider in maintaining this desired state, but uniform volume is required for uniform melting, which cannot be obtained through a large number of small tuyeres. The total tuyere area should be greater than the blast main, or belt area.

Pressure of Blast.

The blast, being atmospheric, is composed of 77 per cent. nitrogen and 21 per cent. oxygen, the remaining 2 per cent. being aqueous vapours. The pressure of blast needed will vary with the diameter of the cupola. A small cupola will not require the same amount as a large one. It is often the case that both small and large cupolas receive either too much or too little air. It is not always easy to fix absolutely upon the requisite amount, as the class of iron is not at all times the same; hence a slight alteration in the blast pressure may be an advantage. For example, if a cupola is charged with pig-iron and very heavy scrap, say chunky pieces from 3 to

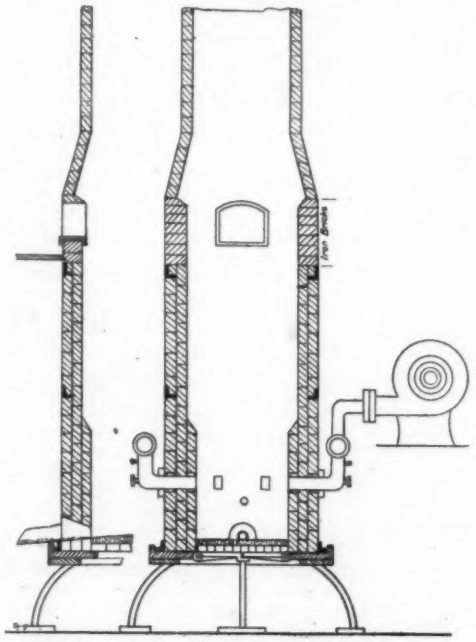


FIG. 1.—SECTION OF DROP-BOTTOM FOUNDRY CUPOLA FURNACE.

4 cwts. each, such material will stand a stronger blast than when the cupola is running on pig and small scrap.

In ordinary foundry work with pig and medium scrap, a 24-in. diameter cupola should not require more than 6 ozs. of blast; a cupola from 24-in. to 48-in. diameter, 8 ozs.; from 48-in. to 60-in. diameter, 10 ozs.; and from 60-in. to 72-in. diameter, 12 ozs. Both the mercury and water blast-pressure gauges are simple in construction and cheap, costing only a few shillings. A sketch of the mercury gauge is shown in Fig. 3. The distance A (Fig. 3) should be not less than the pressure required to be indicated. Assuming that the pressure is 116, the mercury will fall 1 in. below zero in one tube and rise 1 in. above zero in the other; the total difference of levels (2 in.) as shown at B (Fig. 3) equals 116 pressure. The paper scale should be fixed after the tube is filled with mercury. The glass tube can be obtained filled with mercury from any chemist.

The Bristol blast-recording gauge is more expensive, but very accurate, and its daily records can be traced and kept. It should not be claimed that the blast gauge actually measures the amount of blast that passes into the cupola—that is obtained by other means—but it reveals fairly accurately whether or not the normal conditions so far as blast is concerned, are maintained; also it will indicate when the blast is increased or reduced. It is questionable, owing to friction, leakage, resistance, etc., if every foot of air passing into the cupola can be accurately measured; but for normal working the blast gauge is a useful instrument. With a cupola, volume is more important than indicated pressure. It has been shown in some instance, that by doubling the pressure the volume delivered is increased only 40 per cent., and the power consumed increased 170 per cent. It has also been stated that the rate of melting can be increased by increasing the blast up to 18 ozs. pressure. The writer is inclined to think that 18-oz. blast pressure would be detrimental to most brands of iron, unless the cupola was over 100 in. diameter.

Design and Area of Tuyeres.

For cupolas about 40 in. diameter the writer would recommend five round tuyeres of 4 in. diameter, or equal to that area in oval-shaped tuyeres; for cupolas 40 to 56 in. diameter, seven tuyeres 7 in.

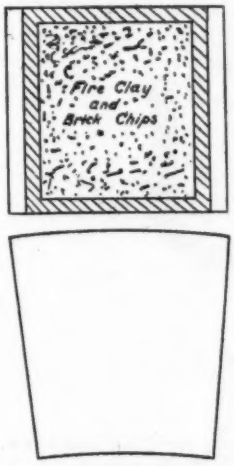


FIG. 2.—HOLLOW IRON BRICK.

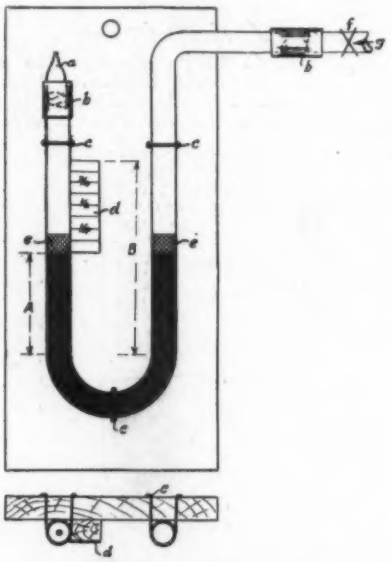
by 4 in. with semi-circular ends; for cupolas 56 to 72 in. diameter, nine tuyeres 9 in. by 4½ in. with semi-circular ends. These dimensions are based upon the best results obtained by experience and practice. In each case the long axis of the tuyere should be in the vertical position.

Charging a Cupola.

After the cupola has been fettled, and the fire has burned through, charging is commenced. If the cupola is lit over night for the next day's blow, extra coke is allowed in the bed charge. In ordinary practice, the bed charge of coke should reach from 12 to 18 in. above the tuyeres, but as cupola's sometimes conduct themselves inexplicably, the exact height of the bed charge in any cupola should be ascertained by experiment. The quantity of coke should be

measured, and varied according to the time and condition of the iron coming down. A few days' careful watching and measuring will determine the most suitable height above the tuyeres, and ensure economical working. Apart from the possible saving in coke, if more coke than necessary is charged the iron will be longer coming down, which means it is longer in contact with the coke, to its detriment, because a percentage of the sulphur in the coke passes into the iron, which often results in a very hard iron. As the bed charge is 10 to 20 times as large as any succeeding charge of coke, it is plainly seen how injurious this may be.

A contention has been put forward that the hard iron sometimes encountered in the first tap from the cupola, is due to the specific state of the carbon, and is caused by the first iron falling on a cold hearth. The writer does not accept this. Granted that the state of the carbon is the cause of hardness, that state is brought about by the influence of sulphur and not from a cold hearth. Dull, sluggish iron may be the result of a cold hearth, but not hard, brittle iron, the analysis of which reveals an increasingly high sulphur content.



a = Glass tube, drawn out to leave small opening, keeps out dust
b = India-rubber tubing.
c = Wire clips.
d = Paper scale
e = Dilute sulphuric acid, to prevent discolouration of glass; black part below = mercury.
f = Stop cock.
g = Air main.

FIG. 3.—SKETCH OF MERCURY BLAST-GAUGE.

Proceeding to put on the first charge of iron, the weight should be determined by the area of the cupola. The writer is convinced that it is common practice to charge cupolas too heavily, both in iron, and coke, which does not induce regular melting and uniform results. The following is submitted:—The weight of a charge of iron for a cupola 24 in. diameter should not be more than 6 cwts.; for a cupola 36 in. diameter, 12 cwts.; for a cupola 48 in. diameter, 20 cwts; for a cupola 60 in. diameter, 25 cwts.; and for a cupola 72 in. diameter 30 cwts.

Following the first charge of iron, coke is charged, and the question arises, how much coke is required per ton of iron? Before deciding that, there are some factors that must not be overlooked, such as composition and cleanliness of the pig and scrap, quality of coke, and class of work for which the iron is required, whether heavy, medium, or light. To mention two extreme instances, if the analysis of the iron show high phosphorus, say, 1.50 or 1.75 per cent., a less quantity of coke per ton of iron can be used than with an iron containing 0.5 or less per cent. of phosphorus. The melting point of phosphorus is 44 deg. C., and the fact that a high phosphorus content increases the fluidity of the iron and lowers the melting point is exemplified in everyday practice. With such phosphoric irons, other conditions being favourable, $1\frac{1}{2}$—$1\frac{3}{4}$ cwt. of good foundry coke per ton of metal will give a hot, fluid iron.

If an iron is used that is low in all the impurities (say, carbon 3 per cent., phosphorus under 0.5 per cent silicon under 1 per cent., and sulphur under 0.04 per cent.), it would have a high initial melting point, and consequently a narrow range of fluidity owing to the absence of the metalloids or impurities named, which assist in retaining fluidity. Such an iron would require 2 or $2\frac{1}{2}$ cwts. of good foundry coke per ton of iron to give a clean, fluid, hot iron. In neither of the instances mentioned above is the bed charge included; in making comparisons it is obviously incorrect to distribute the quantity of the bed charge over the whole melt, as that would be the same in a given cupola for a 20-ton as for a 60-ton melt.

The quality or composition of the coke should be within defined limits, as quality must be considered in relation to quantity used. For cupola practice a low-priced coke may be dear, if it is cheap because it is poor. The evils of an unsuitable coke, apart from the increased quantity required, are manifold. Such a coke militates against a clean cupola, and gives molten iron which is sluggish and dirty. Iron has a strong affinity for sulphur, an element which is generally high in coke of poor quality; and sulphur exercises a detrimental influence upon the castings, rendering them hard and brittle. Further, with a poor coke the ash content is often high, necessitating increased limestone to flux it. A good foundry coke should be high in fixed carbon, low in sulphur, fairly hard, with small pores or cellular structure. The analysis of a good cupola coke is as follows:—

Fixed carbon, not less than	88 per cent.
Sulphur, under..	1 per cent.
Volatile matter, not more than ..	1 per cent.
Ash, under	10 per cent.
Moisture, about	2 per cent.

As an average amount of good coke per ton of iron for medium general work, the writer would quote $1\frac{3}{4}$ cwts., exclusive of the bed charge.

Flux.

Following the coke comes the flux, in the form of either limestone or fluorspar, both of which have been found suitable for cupola work. The function of the flux is to form a fusible slag with any foreign matter, silica, coke-ash, etc., and to some extent reduce the sulphur.

The amount of fluxing material required per ton of iron varies according to the cleanliness of the pig and scrap charged, and also the ash content of the coke. With clean scrap and little silica sand or earthy matter adhering to the pig-iron, and coke having ash within the above analysis, with a suitable limestone, under favourable conditions, as low as 28 lbs. per ton of iron may be used. Under other conditions, however, 60 to 100 lbs. may be required for fluxing. The following is the analysis of a suitable cupola flux:—Lime, 50 to 53 per cent.; carbon dioxide, 42 to 45 per cent.; silica, 0.21 to 1 per cent.; with very small percentages of hydrogen, phosphoric acid and ferrous oxide.

Following the limestone, coke is next charged. It may be here stated that it is advisable to charge only pig on the bed coke, on account of the sulphur from that large amount of coke uniting with the iron. Especially is this important if the analysis of the scrap used is unknown; an appreciable quantity of such scrap in the first charge would probably result in a very hard iron in the first few small ladles, which would make brittle castings if of thin sections. This is not of such importance when a large ladle of iron is tapped first.

With the second charge the pig-iron broken to suitable lengths, according to the diameter of the cupola, should be put on first, and the scrap on top, and so on through the charges. This method assists uniform melting. If thick, heavy scrap is being worked up, then it can be mixed with pig, or melted alone. The best and most favourable results are obtained when the charges, including the limestone, are evenly distributed over the surface area of the cupola. In any case, the light part of the charge of iron should always be on top of the heavier.

Small or thin scrap absorbs more sulphur and looses more silicon and carbon than large, heavy scrap or pig owing to the comparatively low temperature (about red heat) at which sulphur combines with iron. Thin or light scrap becomes red hot some distance above the melting zone, and is much more exposed to sulphur owing to its section in comparison to heavy scrap or pig. Heavy scrap or pig retains its form until the melting zone is reached, but small scrap trickles down abnormally saturated with sulphur, and with reduced silicon and carbon, thus tending to give hard, brittle and white iron.

Fettling and Preparing the Cupola.

It is difficult to say what the length of life a cupola lining should be; it largely depends upon general treatment and the quality and quantity of material used. Considerable damage is done to the lining around the tuyeres and in the region of the melting zone at the end of a blow if the blast is allowed to remain on after the iron is all melted. This apparently results from the presence in the cupola at those points of gaseous combination that violently attack the lining, even though of good refractory bricks. The writer has many times observed, at the close of the day, when a small lot of special iron has been required, and when, to ensure having a clean cupola before recharging, the blast has been kept on rather longer than necessary before and after the melting of the charge, that severe havoc has been wrought in the region mentioned, probably due to the absence of stock to absorb the heat.

When repairing or patching a cupola lining, it is wrong to fill in or daub worn places with a large thickness of fireclay. It is far better to use only sufficient clay to ensure that the pieces of brick used for filling in will adhere to the places requirng to be patched. If a larger amount of small pieces of brick is used, and a smaller amount of clay, the repaired places remain intact much longer.

When patching and repairing is not properly and carefully done before the blast is put on for the blow, the patching becomes mixed up with the charges in the cupola. It is not wise to do much patching when the cupola is very warm, as steam gathers behind the patching from the moisture in the clay, and forces it out, and with the least movement it falls away. When much repairing has been done, a gentle fire should be put inside to stiffen the material used in patching. Also when charging the cupola some care should be taken when dropping the iron or coke near the repaired places, so as not to disturb them until they become fixed and glazed.

The suggestion as to the frugal use of fireclay applies also when bricking the lining of a cupola, and especially when putting in a new bottom. The bricks should be shaped and packed as close as possible, and the clay or ganister, in the form of slurry, run into the crevices, no clay being put between the bricks when packing.

Principles, Chemical Changes, and Phenomena, involved in Melting.

It may be assumed that cast iron, like other metals, is porous; otherwise, heat could not penetrate or be absorbed by it. In melting cast iron there is practically no reduction as with ore or ironstone. The air or blast passing through the cupola tuyeres comes into contact with the burning coke, and by increasing the rate of combustion of the coke, makes it an incandescent mass, with a temperature more than sufficiently high to liquify the iron. As the iron melts, the liquid drops percolate through the partly-burned coke and liquid slag to the bottom of the cupola. Intense heat is thus imparted to the iron, and as the heat is largely retained, the iron remains in a liquid condition for a considerable time, dependent upon the heat imparted and the percentage of phosphorus, silicon, sulphur, etc., contained in the metal.

It will be seen that the cupola is distinct from the blast furnace in that the cupola simply melts or liquifies the metal, whilst in the blast furnace iron is reduced from combination with other elements (as in ore or ironstone) to the metallic state. In the blast furnace the temperature must be very high, probably reaching in the hottest part of the furnace 1,800 deg. to 2,000 deg. C. In the cupola such a high temperature is not necessary, as practically no reduction takes place, and the only oxidation required is that of the carbon in the coke and that necessary for the formation of a free-flowing slag. In fact, if blast furnace temperatures were obtained in the cupola, probably all the iron would be burned. The highest temperature of the cupola at the melting zone under the best conditions, is about 1,600 deg. to 1,700 deg. C.

It may be as well at this point to refer to the two scales of temperature in common use, viz., Fahrenheit and Centigrade. Each degree above 32 deg. Fah. (the temperature at which ice melts) corresponds to $\frac{5}{9}$ deg. C. above 0° (the melting temperature of ice). Fahrenheit readings may be readily converted into Centigrade by subtracting 32 and multiplying by $\frac{5}{9}$ ($F - 32 \times \frac{5}{9} = C$).

There are also in common use two unit of heat:—

(1)The British Thermal Unit (B.T.U.). This is the quantity of heat required to raise the temperature of 1 lb. of water 1 deg. Fah. By experiments it is found that 778 ft.-lbs. of energy will heat 1 lb. of water 1 deg. Fah.; that is accordingly termed the mechanical equivalent of heat.

(2) The Calorie. This is the quantity of heat required to raise 1 gram of water 1 deg. C. Owing to the smallness of the measurement, the heat required to raise 1 kilogram through 1 deg. C. is substituted, and known as the major or large calorie. Calories (major) × 3.968 = B.T.U.

The calorific power or value is the amount of heat a unit weight of a body is capable of yielding when completely burned. For wood charcoal the number 8080 is given, which means that 1 lb. of that body when completely oxidised to carbon dioxide will produce sufficient heat to raise 8,080 lbs. of water 1 deg. C.

Calorific intensity is the pyrometric degree of heat obtained when a body is completely burned. It represents the maximum temperature obtainable under ideal conditions. The temperature attainable with coke in ordinary cupola practice is about 1,500 deg. C. One pound of coke of 88 per cent. fixed carbon

will give 12,700 B.T.U. of heat, which will be its calorific power, requiring 10.21 lbs. of air.

As the required amount of oxygen is forced through the tuyeres of the cupola the formation of carbon dioxide (CO_2) and carbon monoxide (CO) takes place. For economy and efficiency in cupola melting the conditions should favour the production of CO_2 between the tuyeres and the melting zone, which corresponds to the highest temperature attainable. To accomplish this the requisite amount of air must be admitted into the cupola to supply the oxygen for the formation of CO_2; if that is not forthcoming, only the lower oxide, CO, is formed, which indicates a much lower temperature. The calorific power of carbonic oxide is 2,403; the calorific intensity of carbonic oxide when burnt in oxygen is 7,073.

The oxygen of the air combines with its equivalent to form a volume of carbonic acid equal to its own, that is, 30 ozs. of oxygen calling for about 140 ozs. of air, combines 12 ozs. of carbon to form 44 ozs. of carbonic gas.

Mr. F. K. Knowles, in an able Paper upon "Coke and its Properties," states that "Coke supplies the heat and carries the burden, and should be selected with a view to the prevention of the formation of carbon monoxide, that is, a dense non-porous coke. When carbon burns to carbon dioxide, the maximum temperature is attained. If the combustion of the coke takes place on the surface, the tendency to form the lower oxide of carbon is at a minimum, but when the carbon dioxide is forced through the coke by reason of its porosity, the tendency to form carbon monoxide is very great. The result of this reaction is to lower the temperature, as two-thirds of the heat that the coke is capable of yielding is lost, so far as the hot zone of the cupola is concerned."

Iron melts at about 2,400 deg. Fah., 1,315 deg. C.

In cupola practice a large amount of heat is lost by radiation, incomplete combustion, and by passing up the stack, and in addition to melting the iron, heat must be provided for fluxing, so between theoretical heat value and actual cupola practice, a good margin must be allowed; but approximately 1 lb. of coke burned to complete combustion requires 150 cub. ft. of air, and should melt 10 lbs. of iron.

One ton of air contains 515 lbs. of oxygen; air to the amount of 32,000 ft. represents about $2\frac{1}{2}$ h.p., which should be more than sufficient to melt 1 ton of iron.

Mr. W. B. Snow has compiled useful tables, of which the following are extracts:—

I.

6	lb. of iron per	lb. of coke	requires	33,000	cubic feet	of air	per	ton
7	,,	,,	,,	31,000	,,	,,	,,	
8	,,	,,	,,	29,000	,,	,,	,,	
9	,,	,,	,,	27,000	,,	,,	,,	
10	,,	,,	,,	25,000	,,	,,	,,	

II.

From an orifice having 1 sq. in. area, with dry air at 50 deg. Fah. escaping into the atmosphere—

Pressure.	Volume in cubic feet discharged per minute.	Horse Power.
8 oz.	99.9	0.218
16 oz.	139.0	0.606
Increase of pressure ..	..	100 per cent.
Increase of volume ..	..	40 per cent.
Increase of power ..	..	178 per cent.

The latter table clearly demonstrates that the pressure should be kept low and within practical and economical limits.

The amount of heat required to melt 1 lb. of iron is 504 B.T.U. The amount of heat obtained in burning 1 lb. of charcoal to carbon dioxide is 15,000 B.T.U. The amount of pure carbon required to melt 1 ton of iron is 77.85 lbs.; and the amount of pure carbon required to melt 1 lb. of iron is 0.034 lb.

The approximate analysis of coke ash is as follows:—

	Per cent.
Silica	30 to 60
Alumina ferric oxide	35 to 55
Lime	5 to 10
Magnesia	0 to 2
Sulphuric acid	3 to 8
Phosphoric acid	0.5 to 7.5
Potash and soda	2 to 4

Cupola Flux.

In addition to coke ash there is charged into the cupola with the pig-iron and scrap a certain amount of foreign matter, such as silica, sand, and dirt, which is chiefly acid. Accordingly a material which is basic must be added, which will in the fusion zone unite or combine to form a fusible free-flowing slag. The material in a cupola to be fluxed is chiefly acid, and the fluxes mentioned earlier (limestone and fluorspar) are basic.

An acid is the oxide of a non-metal, a base is the oxide of a metal, and both have a strong chemical affinity for each other, depending upon the compound. The oxides of all metals, however, are not basic. Acids and bases react and combine in definite proportions.

When the limestone (calcium carbonate) charge into the cupola, reaches the hot zone, quantities of carbonic acid are evolved to the accompaniment of popping and cracking of the pieces, resulting in lime which remains as such until the temperature of about 1,800 deg. Fah. (980 deg. C.), is reached, when it combines with the silica and other foreign acid matter to form the slag.

Pure limestone contains 56 per cent. of lime, and 44 per cent. carbon dioxide gas, the molecular weight being 100. Fluorspar (calcium floride) is regarded as a more effective flux than limestone, as it is claimed to also reduce the sulphur in the iron. It acts as a flux on silicates in two ways:—(1) By combining with the silicates to form a fusible compound; (2) by decomposing the silicates and forming gaseous silicon fluoride ($Si F_4$).

Both fluorspar and limestone are lime-producing. Weight-for-weight fluorspar contains about 10 per cent. more of lime-producing calcium than limestone, and while 44 per cent. of limestone is volatilised and passes up the stack of the cupola, the whole of the fluorspar is utilised, owing to its non-decomposition until the fusion zone is reached, where its function is performed in producing a very fluid and thin slag.

In practice the most satisfactory flux is a mixture of both limestone and fluorspar. Nearly half the limestone early dissociates, and the remaining lime and the fluorspar reach the incandescent mass together and do the fluxing efficiently, while also distributing themselves over the molten iron, protecting it from the cooling and oxidising effect of the blast. To use a sufficient quantity of fluorspar only would not make sufficient slag to give this protection.

Limestone is lime combined with carbonic acid gas (carbon dioxide). Fluorspar is calcium (the base of lime), combined with fluorine, a gas much more chemically active than carbon dioxide. The form in which the calcium is released is not that of lime, as in the case of limestone, but as calcium according to the following three equations:—

$$(1)\ Ca F_2 = Ca + F_2.$$
$$(2)\ 2 Ca + O_2 = 2 CaO.$$
$$(3)\ Si + 4 F = Si F_4.$$

If the fluxing material is limestone, it is soon decomposed by the heating action of the ascending

gases. The carbon dioxide (CO_2) escapes through the stack, while the descending lime combines with the silica to form a silicate of lime.

$$CaO + SiO_2 = CaSiO_3.$$

Lime + Silica = Calcium Silicate.

First :—$CaCO_3 = CaO + CO_2$—that is, limestone is reduced to lime and carbon dioxide is driven off.

Second :—Lime combines with silica, forming lime silicate—$CaO + SiO_2 = CaOSiO_2$.

Third :—Iron oxide combines with silica, forming ferrous silicate—$FeO + SiO_2 = FeSiO_3$.

Final :—Lime combines with iron sulphide, forming calcium sulphide and ferrous oxide—$CaO + FeS = CaS + FeO$.

With cupolas that are running daily on one class of iron, the fluidity or sluggishness, colour, and general appearance of the slag should be some indication of the condition, whether favourable or otherwise, during melting. Slags vary in colour from grey to black, and may be classed as silicates and aluminates, and are the results of combinations of silica, alumina, lime, iron, etc., as silicates. The condition of the slag is affected by the coke, blast, and quality and quantity of the flux, but if these are favourable, a medium colour free-flowing slag indicates a sufficiency of limestone and a desirable absence of abnormal ferrous oxide. A sluggish, thick-flowing, dull black slag indicates a scouring condition, and this slag will be found to be high in iron oxide, this arising from various causes.

As shown, slag is produced by the oxidation of silicon, manganese and iron, and also adhering sand and dirt on the iron charged, and in addition the ash in the coke and fluxing material charged.

Typical analyses of Cupola Slags.

Silica. (SiO_2)	Alumina. (Al_2O_3)	Ferrous oxide. (FeO)	Lime. (MnO)	Manganese oxide. (CaO)	Magnesia. (MgO)	Sulphur. (S)	Calcium. (Ca)
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
56.1	11.3	15.3	3.50	9.75	0.60	0.17	0.23
55.2	11.6	9.9	1.16	15.52	0.49	0.22	0.28
50.4	10.6	24.9	4.0	9.80	0.74	0.18	0.22
46.7	9.3	7.3	2.79	31.6	0.15	0.40	0.50

The above table is by Mr. Albütz, who points out that it shows the action and influence of the acid and basic agencies; silica (SiO_2) as an acid, and lime (CaO) and iron oxide (FeO) as bases. It will be seen that by a decrease of silica, there is an increase of either lime or ferrous oxide. Alumina (Al_2O_3) remains fairly constant.

Cupola slags may be summarised as a compound union of acids and bases, which have a strong chemical affinity for each other. The approximate analysis of a normal typical slag is as follows :—Lime, 25 per cent.; ferrous oxide, 5 per cent.; alumina, 10 per cent.; silica, 49 per cent. The oxides occurring in the slag are classified by Mr. Swinden as follows :—

Acid.		Basic.	
Silica, SiO_2	..	Lime	.. CaO.
Titanic acid, TiO_2	..	Iron oxide ..	.. FeO.
Phosphoric acid, P_2O_5	..	Manganese oxide	.. MnO.
Sulphuric acid, SO_2	..	Alumina ..	.. Al_2O_3.
		Magnesia ..	.. MgO.
		Soda	.. Na_2O.
		Potash	.. K_2O.
		Baryta	.. BaO.

Neutral substances (neither acid nor basic), such as calcium sulphide (CaS), and calcium fluoride (CaF_2) may be present.

British Foundrymen's Association.

Lancashire Branch.

The opening meeting of the 1912-13 session of the Lancashire Branch of the British Foundrymen's Association took place at the Municipal School of Technology, Manchester, on October 5, when Mr. F. Penlington delivered his Presidential address.

Mr. Penlington, having thanked the members for the honour done him in his re-election, and for the loyal support accorded him during his year of office, paid a warm compliment to Mr. H. Sherburn, the late Hon. Secretary, to whom he said the success of the Branch was very largely due. He also congratulated the members on the acceptance of the office of Hon. Secretary by Mr. A. Harrison.

Turning to the immediate purpose of his address, he remarked that the necessity for the British Foundrymen's Association became apparent when they considered that every other branch of the engineering trade had for many years possessed such an institution of its own, devoted to the study of the requirements of its particular section, and the collecting and tabulating the necessary data and formulas for arriving at desired results. Yet for a long period the most important section of the trade had been content to flounder along as best it could, under more or less rule-of-thumb methods, coupled with information gained by years of practical experience, handed down from father to son. They were met with the fact, however, that the demand for castings was greater to-day than ever before, while the designs were more complicated and specifications more exacting. The need for such an Association as that to which they belonged was, therefore, too obvious to call for proof. The objects of the Association were, firstly, to arouse the interest of those who had to deal with foundry products, whether as makers or dealers, and to convince them of the need for more systematic and intelligent methods of dealing with castings. Secondly, having convinced foundrymen that it was absolutely necessary to discard obsolete and "rule-of-thumb" methods, they must be prepared to educate them, and demonstrate that with the knowledge gained by scientific research they could eliminate much that was detrimental, while blending and controlling the various metalloids and other elements they had to manipulate. The results would thus become more reliable; they would be in a position not merely to expect, but to depend upon getting better results than heretofore, both practically and financially.

Bearing in mind these two points, and supposing them to have been achieved, they came to a third most important object, that, namely, of placing the foundry and the foundrymen in the position they ought to occupy—the forefront of the engineering

trade. No other branch of the trade was so complicated or dependent so much on the personal skill and on the constant and unremitting attention to details on the part of the craftsman. The pattern-maker had the timber and the tools, which, combined with the practical and technical knowledge he possessed, enabled him to convert the metal from its crude state into the shape and size conceived by the designer. He could also see, handle and measure as he went along, and from time to time as the work progressed he could make any alterations which were desirable; while finally, when the work was finished, having overhauled each detail and found them satisfactory, he could say with pleasure—"This is what was required, it is correct in every particular, and is a piece of work worthy of a craftsman and goodly to look upon."

Pretty much the same obtained with the engineer; he was given a casting which he could see and handle; it conformed to the general size and shape of the finished product, he could measure it, and mark outlines to enable the machineman to give it the dimensions required, and with the aid of machines of various kinds, with tables of speeds and grades, he could shape and build together various pieces until the complete machine was ready to be delivered to the customer. The point he (the speaker) wished to make was that all the time, and throughout all the different operations, the engineer had something tangible to manipulate, something which he could see and handle, and he was also able to correct his measurements during the progress of each operation. With the foundryman it was entirely different. Even when he had a good pattern and a proper equipment of boxes, much still depended on the personal element; such as the tempering of the sand, which if too wet or too dry would not fulfil the conditions needed to make a good casting. Again, if rammed too hard, or not hard enough, trouble would ensue. Moulds not properly vented; cores not correctly set, or insecurely fastened; runners and gates not carefully made, either too large or too small, or not put in the place just fitted to receive them; these were all sources of disaster, any one of them being overlooked or neglected meaning perhaps the loss of days' or even weeks' work. There was not, so far as his knowledge extended, any machine gauge or measure whereby the moulder could know how much water to put to a given quantity of sand for castings of various thicknesses, or to inform him how hard to ram the sand round a pattern, or how many gates or what size of runners should be placed in the box in order to get the desired result. Hence all the operations depended for their proper performance upon the skill and practical knowledge of the moulder. The casting temperature was also largely a matter of experience, and no amount of technical training could supply the deficiency of practical knowledge.

Having thus dealt with the qualifications for a good craftsman, he had next to insist upon the foundry being situated and equipped in a manner equal to those conditions which obtained in other departments of the engineering trade. Ever since the days when King Solomon ordered his craftsmen to go into the plains of Jordan, between Succoth and Zeredathah, to cast the pillars that stood at the entrance to the Temple, it seemed to have been taken for granted, that anywhere and any kind of place was suitable for a foundry; and though great improvements had been made of recent years, from economic considerations, in building and equipment, much yet remained to be done before moulders could be said to have received such consideration and granted such facilities as to enable them to follow their calling under decent conditions, and attract the best class of individuals to adopt it.

Although cast iron was known in the time of Aristotle, 350 B.C., founding was not carried on to any large extent until the end of the 17th or beginning of the 18th century, when, after the Dudleys had exhausted their capital and were, moreover, handicapped by the restrictions relative to the cutting of trees in the forests wherewith to melt the iron, a few pioneers experimented in the making of the metal from ordinary coal. With the assistance of workmen imported from Holland, they were so successful that the result was still in evidence to-day in the celebrated Coalbrookdale Iron Works. While however, they were proud, and justly so, both of scientific and practical founding, they were greatly concerned as to the position to which the craftsman was drifting under modern economic developments. The introduction and equipment of moulding machines and plate moulding was creating a class of workmen, who, although highly skilled in one particular class of casting, were not, nor ever could be, craftsmen in the true sense of the word. Moreover, they were eliminating the apprentice who served his time to general founding, for though it was perfectly true there was no moulding machine yet invented which possessed brains, still the operations were so detailed and so systematised, that a few days or a few weeks sufficed to teach an intelligent man the art of manipulating a machine, and turning out a better article and in larger quantities than was possible under the old conditions. This afforded one reason why they, as an educational society, should do their utmost, as indeed they were doing, to encourage the practical artisan to take a greater interest in his calling, and urging him to visit technical and scientific institutions, where he might become acquainted with the results of the latest researches by eminent professors and teachers. They were also anxious to inspire their members with the spirit of inquiry and the cultivation of a habit of careful observation of the various phenomena which came under their notice, so that if possible they might discover the causes of the different effects they experienced.

The annual Conference recently held at Cardiff discussed at some length a paper read by Mr. J. W. Horne, on the "Training of Apprentices," and appointed a sub-committee to consider the question, and report to the Council what, in their opinion, would be the best means to adopt to promote the better education of young foundrymen. That showed at once the importance of the subject, and the need for providing a remedy for an evil which had resulted from the commercial and economic development of the trade. There could be little doubt that unless strenuous efforts were made to encourage and interest young moulders in their calling, beside offering them a few shillings extra per week for pounding sand, they would most assuredly lose the skilled craftsman, and replace him by an animated machine for making profit. The Association must also bring before the employers and engineers of the country the desirability of encouraging their young men to join its ranks, in addition to giving them facilities for learning the trade, discussing its various problems, and experimenting when and wherever opportunities occurred. They must also cultivate the confidence and esteem of employers, so that the fact of a man being a member of the British Foundrymen's Association would be a good recommendation in itself for the position of manager or foreman. When those objects were attained they might hope that much of the conservatism and secrecy which prevailed at present in regard to the various classes of work and

the methods of doing it would be removed, so that employers would permit moulders to discuss the methods and measures adopted by them in carrying out their operations. Such a state of things would be better both for the individual workman, the different firms, and, in fact, for the whole body of the trade.

It was an old saying, and in some cases at any rate a true one, that the man who was afraid of letting others know what he was doing had not much to reveal. It was in this spirit, encouraged as it had been by the success of the open meetings last year, at which the members raised and discussed a variety of foundry problems, that the Committee had decided to give even greater facilities in that direction, by devoting two additional dates during the coming season to the same purpose. They intended, if possible, to induce some members on those occasions to introduce problems, the consideration of which should bring them nearer to their everyday work, foster the spirit of discussion, and incidentally develop the faculty of observation and of expressing ideas which occurred to their minds. Many members would like to read a paper on some particular subject which was of interest to them, but were deterred by the knowledge that they were expected to write something which would occupy from 20 minutes to half an hour in the reading, whereas after much effort and thought they could not produce more than would take up about five or ten minutes. Those were the members whom the Committee wished to encourage, and they hoped as the result of the "open meetings" that they would be persuaded to come forward and deliver short addresses. A five minutes' paper, or even one question, would often be more productive of discussion than a half-hour paper dealing with a technical or scientific subject. Subjects which might well be introduced were:—The mixing iron from analysis and the method of calculating mixtures for various requirements; various methods of handling large numbers of small orders; systems of keeping trace of patterns and core boxes; relative costs of different ways of moulding the same castings; loose pattern jobbing, moulding tub, bench, machine and plate moulding, together with approximate cost of equipment for different classes of moulding; best methods of running castings, together with the controversial question of open or closed risers; cores and core-making with relative core costs in proportion to moulding; various methods of core-setting; securing and stripping cores from moulds and castings; calculating weights of castings and estimating times and costs for specification purposes; cleaning and storing patterns and core boxes; and best methods of making plate patterns and mounting patterns on machines. Those were a few of the subjects which could be introduced in short papars, and would be likely to promote profitable discussion.

To show the progress of the Branch, concluded the speaker, he had only to mention that whereas in 1910 they had 98 members, they had now 132, a substantial increase, notwithstanding that they had transferred 14 to the recently-formed Halifax Branch.

Discussion.

Mr. T. W. Markland said that in the course of his excellent address the President had thrown out many suggestions which, if followed up, would prove very beneficial to the Branch. He hoped some of the members would volunteer to give them five-minute papers, either on one of the questions mentioned by Mr. Penlington or on any other in which they might feel interested.

Mr. W. H. Sherburn was glad the President had referred to the discussion which took place at Cardiff on the position of foundry apprentices at the present time. Both the paper and the subject demanded very serious consideration; it was not the simple matter it appeared to be on the surface. No doubt some portions of the work of a foundryman was unpleasant, which caused many lads to fight shy of it, while moulders, as a rule, would put their boys to any calling rather than their own. That was one reason why they had such a poor class of boys taking up the calling now. Then, again, they could not overlook the fact that the financial aspect was in these days regarded as of great importance. He regretted the apprenticeship system had declined so much, but, after all, what was an apprentice to moulding going to learn under existing conditions? Machinery and the sub-division of labour had brought matters to such a pass that the moulder was an unintelligent labourer rather than a craftsman. Boys were put into the shop, and before they had been there very long they became workmen to all intents and purposes, getting so much per cent. for doing the same work that men did. That was a very deplorable state of things, and called for the earnest consideration of all foundrymen. They ought to be able to offer a lad some prospect of following his trade when his time was up, but at present when they saw a shop three parts full of boys, they could not avoid asking the question: What they were going to do when they became men? He would very much like to listen to a paper on the apprenticeship question at one of their meetings, and hear it discussed. (Hear, hear.)

Mr. Walker said that when he began to serve his time he had great difficulty in getting into the work of moulding. Applicants were numerous, and boys fought for admission; but a great change had taken place. He recently wanted two apprentices and was unable to get them. Boys preferred now to go into the cotton factories rather than the foundry, because they could obtain scholarships and attend secondary schools until they were 14 or 15 years of age.

Mr. Nicholls remarked that in time past apprentices were pushed forward from one kind of work to a better kind, but now-a-days masters would not give them more opportunities of learning their calling. The boys accordingly got disheartened, and would not try to do the best they could and would do if they were properly encouraged when they showed capacity. That was the cause of the deterioration in craftsmen, and the only remedy was, as he had said, to give them some encouragement.

The President thanked the members for the way in which they had mentioned one or two questions referred to in his address, especially the apprenticeship question. It was a very complex question, and he thought the economic element had more to do than anything else in eliminating the old class of foundrymen. At one time the apprentices used to have everything explained to them as opportunity offered, both in the dinner hour and in the evening. He found, however, that at the end of two or three years they would ask for more money, or they would shoot off to somewhere else where they could get more. The consequence was that he was always dealing with raw material, so to speak, and therefore he gave up training them. At the same time he was very interested in the apprenticeship question from the educational point of view, for unless they bestirred themselves they would find the apprentice superseded by an automatic or semi-automatic machine.

A cordial vote of thanks was passed to the President for his address.

Foundry Equipment at the Engineering Exhibition.

The Engineering Exhibition at Olympia which was held last month, included a number of machines and appliances of interest to the foundry and pattern shop. Particulars of some of the items shown are given herewith.

Wood-Working Tools.

WADKIN & COMPANY, Leicester, had an exceptionally interesting display of wood-working tools, prominent amongst which was the "Wadkin" mechanical woodworker, specially designed for the work of the foundry pattern shop. This machine, which has already been described and illustrated in our columns, was shown in operation, on actual examples of corebox, pattern, and similar work. Some other machines shown are illustrated herewith. A very useful machine for the pattern shop which was shown was a 16-in. double dimension saw, illustrated in Fig. 1. The machine is suitable for ripping, cross-cutting, bevelling, tongueing, grooving, mitreing, sticking small mouldings, cutting compound angles, and roughing out of core boxes, and a variety of work found in every shop. The main frame is cast in one piece, and inside the body is a partition cast solid with the main frame, dividing the inside into two distinct parts, one in which the saws are accommodated and the sawdust collected, the other containing the pulleys, bearing and belts, so that these are kept free from the dust. The dividing partition is heavily ribbed, and has a machined circular opening 21-in. diameter, forming a large solid bearing for the turned disc which carries the saw spindles frame. This obviates the use of any outside bearing to the saw frame, and removes any hindrance when putting saws on and off. The cast-iron door at the front of the machine entirely covers the saws and gives ample protection to the operator. The table is divided into two parts, the right-hand half being stationary and the left-hand half sliding to and fro. This sliding half of the table is carried on a frame supported on extensions of the fixed table. The entire table tilts through the various angles up to 45 degrees with the horizontal; a graduated index conveniently placed shows the operator at a glance the angle to which the table is canted. The sliding table runs upon Hoffmann ball bearings confined in angular raceways, the balls being held in special phosphor-bronze cages.

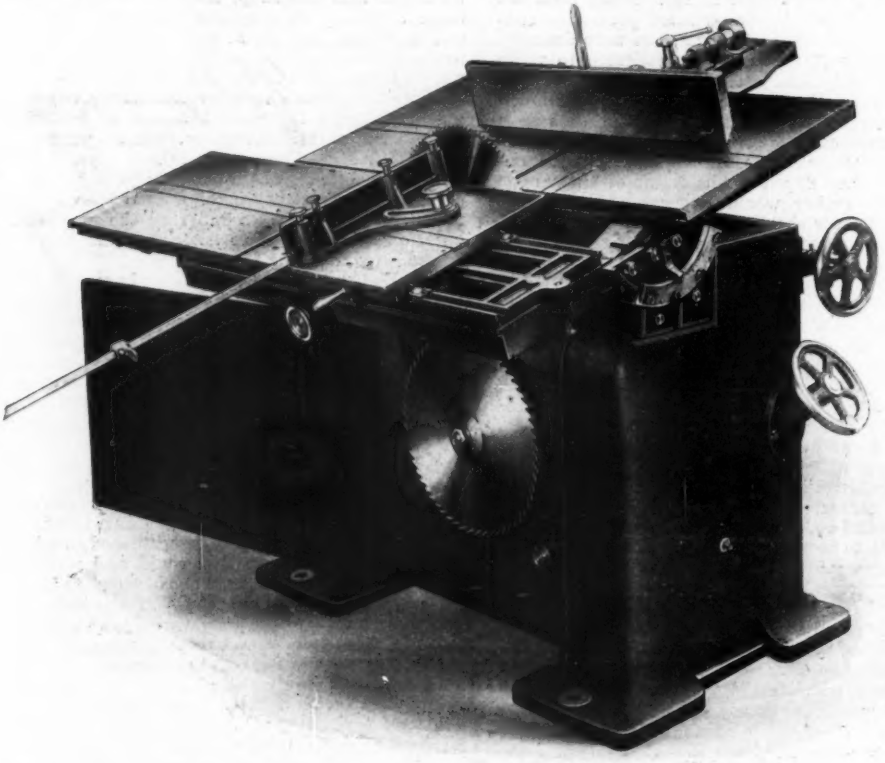


FIG. 1.—16-IN. UNIVERSAL DOUBLE DIMENSION SAW, BY WADKIN & COMPANY, SHOWING FRONT OF MACHINE OPEN AND SAW TABLE CANTED.

Long lift plates running against machined ways keep the sliding table in place. This sliding table is carried on an intermediate frame, having a movement by screw and hand-wheel in a direction away from the main table, thus forming an adjustable width of gap. Convenience is provided for attaching a wooden gap plate through which grooving saws or cutters can project. The saw-table is tilted by means of cut worm, worm-wheel and bevel gear operating an arm and lever; this motion is self-locking and conveniently placed. The cast frame carrying the two saw spindles has a turned disc at one end and a turned bearing at the other end; to the latter is attached a cut worm wheel for revolving the saw frame, which can be operated whilst the machine is left-hand, the angles being suitably marked on the table surface. A spring plunger-pin, used in conjunction with certain holes, gives the standard angles without referring to the index on the table; an adjustable sliding stop-rod and clamps are fitted with a second adjustable stop for long work.

The 7-in. vertical reciprocating belt sander illustrated in Fig. 2, was also shown. This is an entirely new machine, and was designed especially for use in the engineer's pattern shop. The machine is so arranged that it is possible for three men to be making use of it, without being in each others way; another very important point is the reciprocating belt co-jointly with its high lineal speed, which ensures the finish of the work being of the highest quality. The re-

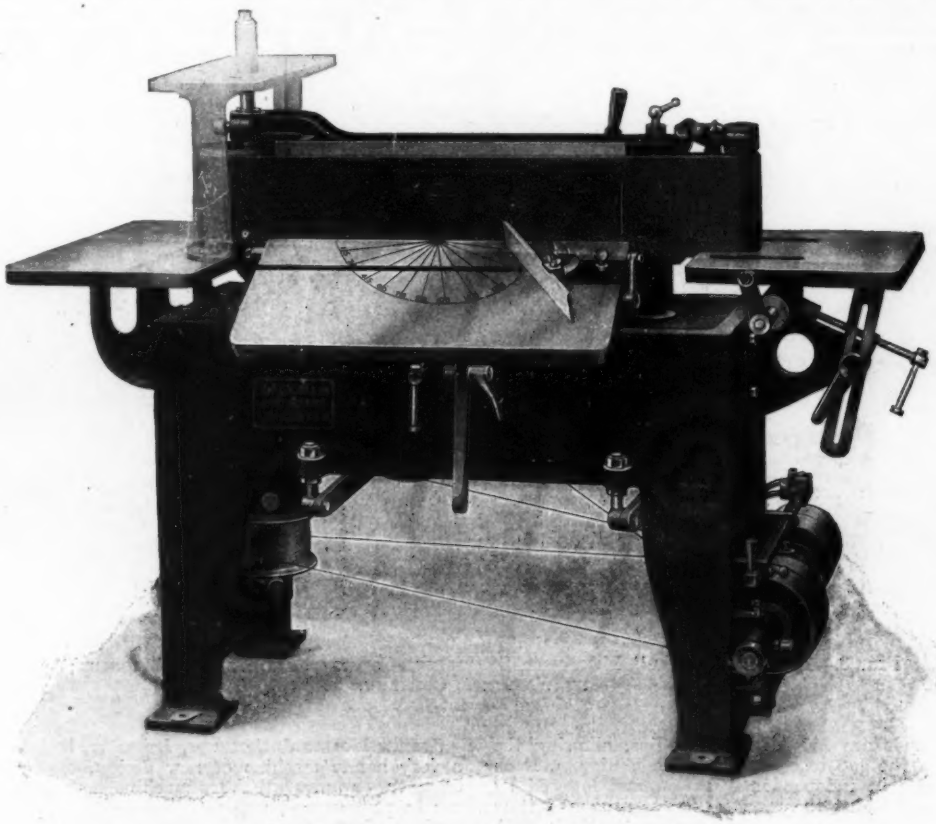


FIG. 2.—VERTICAL RECIPROCATING BELT SANDER; BY WADKIN & COMPANY.

running or standing; a convenient hand-wheel operates this mechanism, which is self-locking; a phosphor-bronze adjusting ring and screws take up all end shake. Each saw spindle bearing is cast solid with the frame; the bearing next to the saw in each case contains two Hoffmann ball bearings, and the remaining bearings contain one single Hoffmann ball bearing. The cast-iron ripping fence has a front fence plate which cants from the vertical to 45 degrees. It is also arranged to swivel 35 degrees either way, an index being provided. The fence has a quick motion across the table by hand and a fine adjustment by screw; it can be used on the sliding table if desired. The cutting-off gauge is used on the sliding table, and is arranged to swivel right- and ciprocating sand-belt frame is a heavily ribbed casting, having at one end adjustable phosphor-bronze bearings, carrying the large sand-belt drum and shaft; the small sand-belt drum is arranged to run in phosphor-bronze bearings carried in a special swivelling bracket, which slides backwards and forwards in a special boss at the other end of the frame. The sliding motion imparted to this bracket is controlled by lever for the purpose of tightening the sandpaper belt, whilst the swivelling screw adjustment allows the belt being tracked so as to run perfectly true on the sand-belt drums; this latter adjustment is only required when a new belt is put on the machine. The vertical reciprocating motion is obtained by means of a double-ended crank shaft,

operating two adjustable lifting levers, which are applied to the vertical slide rods of the reciprocating sand-belt frame in conjunction with adjustable balanced springs, and in such a manner that the vertical lift of the frame at all times is accurate, positive and properly timed at both ends, quite irrespective of the work being done at either end. The work tables are three in number, one fitted to the large drum, one to the small drum, and another fitted at the side of the sand-belt. The two latter tables cant above and below the horizontal, enabling bevelled work to be operated.

A 16-in. "Diploma" hand-feed surfacing machine, which was exhibited, shown in Fig. 3, has been designed with a view to particular accuracy in the work produced. The main frame is a heavy cored casting all in one piece; the tables are cast iron, well ribbed on the underside, the working surfaces being accurately planed and scraped dead true; the adjacent ends are fitted with steel lips, allowing the width of the gap to be reduced to a minimum. Each table may be independently raised and lowered by handwheel whilst the machine is running, and it is quite impossible to foul the cutterblock. A horizontal adjustment by screw and handle allows the tables to be withdrawn, to give the operator ample room when changing or sharpening the cutters. All adjustments are conveniently arranged. The fence cants from the square to 45 degrees relative to the table. It is provided with pressure springs, and has quick adjustment across and up to the front edge of the table, enabling rebating without change of cutters to be operated; also the full width of the cutterblock is available without removing the fence from the table.

The 36-in. "Diploma" band-sawing machine, which was exhibited by the same firm, is substantially built, rigid and sensitive, and is fitted with ball bearings in dust-proof housings. The table cants 45 degrees to the right, and 5 degrees to the left, by means of screw and handwheel; a conveniently placed pointer and index indicates the exact angle. A removable hardwood saw gap plate is fitted, and the saw gate is as small as possible, and does not require to be widened when the table is canted. An extension table of ample size is fitted. The saw pulley shafts run on ball bearings carried in dust-proof housings; the housings for the bottom shaft are mounted on machined seatings on the main frame, and the top pulley shaft housings are sensitively mounted on a special swivel slide, controlled by handwheel and screw, which allows the saw to be properly tracked whilst the machine is running, and without disarranging the tension of the saw. Both saw pulley rims are covered with rubber. The tensioning of the saw, from the narrowest upwards, is automatically regulated by a telescopic spring device, which instantly adapts itself to variations in the tension, due to expansion or contraction arising from any cause. A brush, which may be adjusted, keeps the bottom saw pulley free from chips, sawdust, etc.

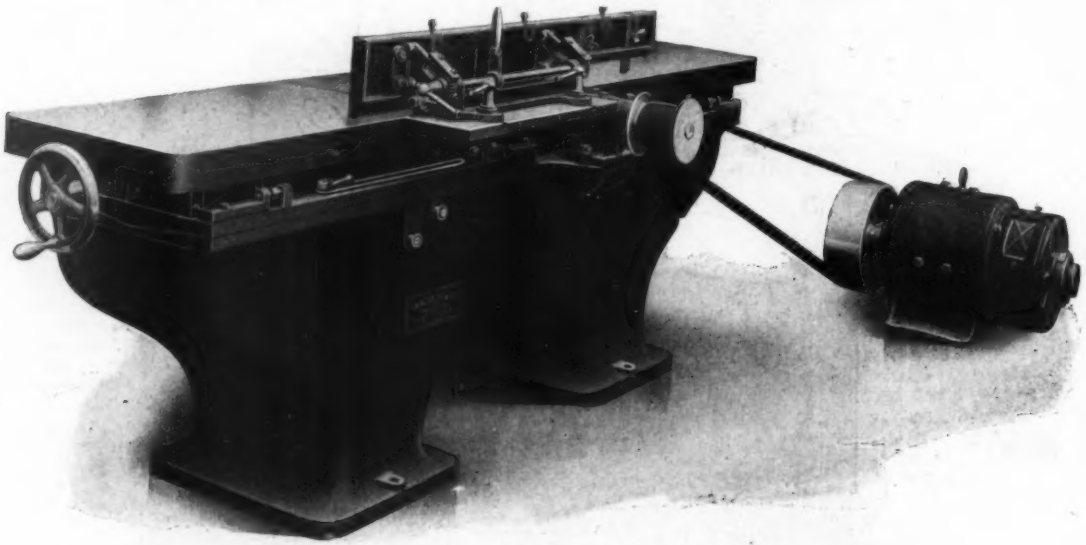


FIG. 3.—16-IN. "DIPLOMA" HAND-FEED SURFACING, JOINTING, AND PLANING MACHINE; BY WADKIN & COMPANY.

JOSEPH HOLLIS & COMPANY, Leicester, had on view a very handy machine of new design, of the wood trimmer or universal mitre machine description, for use in pattern and woodworking shops. This woodworker, which was shown in operation, is illustrated in Fig. 5. It is provided with fittings for performing a number of operations which cannot be performed on the ordinary wood trimmer. For example, it automatically measures by a Government stamped rule, all dead-length work; it automatically fits all moulds or fillets at one cut to exactly fit all angles or splays; it has a canting table which rests on the marked degrees on fences at 45, 60, and 67½ deg., to cut 21 in.; while also a special feature is that the knives can be raised or lowered, so as to wear the full length of edge, instead of only one part, as is usual. All the slides are tightened by adjustment strips and screws, and the driving wheel has a ratchet handle to alter to suit positions. It is claimed to be the only machine on the market which is fitted with four fences, two external, two internal, so that both angles can be cut without moving either, while we also understand that it is the only trimmer

provided with three mitre positions, at 44½, 45, and 45½ deg., with stop pins so as to use either to make up for the difference when cutting hard woods and soft woods, or for doing work when the knives are dull, because at such times dull knives push off the work more or less. No knife, it may be remarked, cuts the same mitre with hard wood as with soft wood. Another new feature is provided for cutting bolection moulds for panels which are deeper than the rebate or moulds.

The business of Joseph Hollis & Company has now been taken over by H. A. Harvey & Company,

FIG. 4.—36-IN. BAND SAWING MACHINE; BY WADKIN & COMPANY.

Limited, Norfolk House, Laurence Pountney Hill, E.C., who were also showing among other exhibits on their stand a "Standard" saw bench with boring attachment, fitted with self-oiling bearings, canting and swing-over fence, safety belt shifter, rise and fall table, etc.; a wood trimmer, giving a length of cut of 11 in.; and an improved disc sander mitre cutter.

Moulding Machines.

THE UNIVERSAL SYSTEM OF MACHINE MOULDING AND MACHINERY COMPANY, LIMITED, London, had an excellent exhibit of their system of machine moulding, which attracted a good deal of attention. This system will be dealt with fully in a near issue.

BRITANNIA FOUNDRY COMPANY and the ADJUSTABLE MOULDING MACHINE COMPANY, Coventry, had on view several of their admirable moulding machines. The "Coventry" machine, hand-power, gear-driven, with a pressure up to 12 tons if desired, was shown. This machine was described in our issue of November, 1907, and is familiar to our readers. The "Adjustable" machine, a simple but handy apparatus for hand-ramming, and giving an accurate draw of 8 in., was another interesting item of the exhibit. This machine, which was described in our issue of September last, can be instantly adjusted to take any size of box from 8 in. to 24 in. square. On a very intricate job a large amount of ramming is of necessity done by hand, and for this class of work, where ramming by power is unsuitable, the above machine is very efficient. This machine can also be fitted with a turn-over table when desired. The machine which attracted the greatest attention, however, was a new design of the "Coventry," which the maker has just evolved, the one shown on the stand being the first complete machine of this design to be made. The ramming of the mould occupies only 7 seconds. Detailed particulars and illustration of this will be published in a near issue of our paper. The capacity and application of the machine justly singled it out as an apparatus of special merit in the moulding-machine world, and keen appreciation was expressed by a number of foundrymen who inspected it. A sand-mixer (Alfred Herbert's patent) was another interesting feature of the exhibits on this stand.

ALFRED GUTMANN, A.G.-für-Maschinenbau, Altona-Ottensen.—The British representative of this Company, Mr. H. R. Witting, 41, Berners Street, London, W., was exhibiting a sand-blast cleaning plant, comprising a rotating table installation with automatic sand-blast, compressor, air chamber, and exhauster for absorbing the dust produced. The rotating table has a diameter of about 50 in., and is regularly covered with sand by means of a circulating nozzle. An arrangement is provided on the table for absorbing the dust, and there is also an elevator for reconveying the sand to the sand-blast. At the outlet of the elevator there is an arrangement for separating the blast sand from any fine dust mixed with it. The nozzle is fed by a patented sand-blast which automatically passes the sand as required for the work. On the rotating table castings can be cleaned up to any size of about 20 in. by 16 in., and about 12 in. deep. The output per hour of the rotating table is about 10 cwts. The total power required for working the installation is about 7 or 8 h.p. It may be mentioned that the sand-blast appliance can be used for a free blast, and could then be

employed on castings of too large a size to be accommodated on the rotating table.

THE KOENIGLICHE WUERTEMBERG HUETTENWERK, Wasseralfingen, Germany.—This concern, also represented by Mr. H. R. Witting, London, were exhibiting several moulding machines for foundry use, one being a hydraulic machine with two mould carriages for double-sided ramming, with vibrating pattern-plate supports and an electric vibrator. This machine handles boxes of about 13 in. by 23 in. There is a special stopping appliance on either side of the machine, operated by a hand wheel. A reversible-table hand-power moulding machine for mould boxes of 13 in. diameter, and a hand-power lifting moulding machine, in which boxes of 17 in. diameter are lifted by turning a hand wheel, were also shown, and in addition a model of a hand reversible-table moulding machine with three-sided counter-pressure plate for double-sided ramming. Foundry sand riddles, and a selection of castings made on the machines were other items, while the exhibit also included a hydraulic accumulator for about 25 pints contents, and an electric motor driving a triple pump.

strong and inexpensive, while we are told that the service given is thoroughly reliable, as proved by a large number of successful installations.

The latest type of "Foster" fixed-focus radiation pyrometer which was shown is illustrated in Fig. 6. This outfit comprises in a very small compass a complete pyrometric equipment. The illustration shows the instruments and their leather carrying case. The fixed-focus receiving tube is made jointed for convenience in packing inside the leather case. It is arranged to be read in connection with a portable direct-reading indicator, and is connected thereto by a length of flexible cable. The same indicator has also a second scale for use with a Hoskins alloy thermo-couple, and a flexible couple of this type is included in the outfit. There is also a collapsible tripod for holding the fixed-focus receiving tube when extended observations are to be made. The standard ranges with the outfit are 200-900 deg. C. for the Hoskins thermo-couple and 700-1,400 deg. C. with the fixed-focus pyrometer. The latter portion of the outfit can be supplied if desired with higher range, up to 1,800 deg. C. This outfit is particularly suitable for steel-works' use.

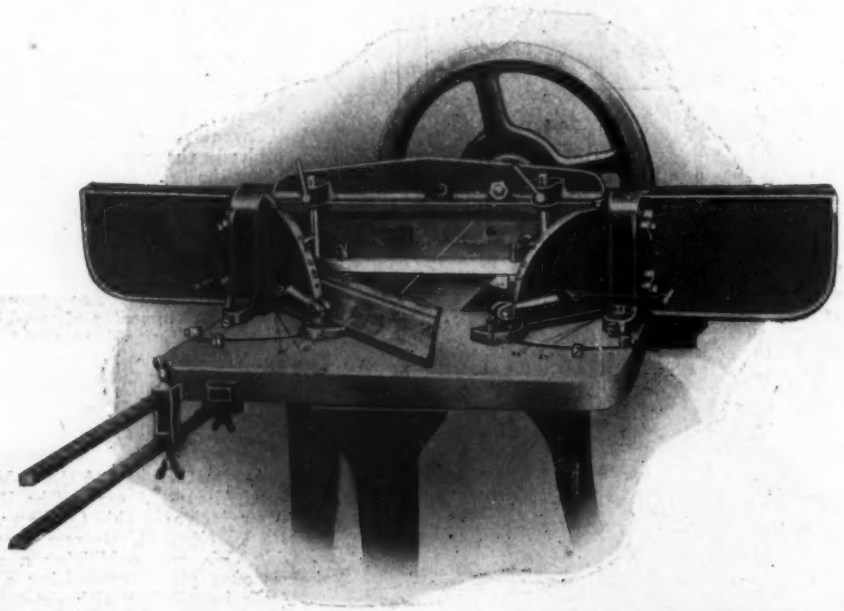


FIG. 5.—THE "MASTERPIECE" WOOD TRIMMER; BY JOSEPH HOLLIS & COMPANY, LEICESTER.

Foundry Pyrometers.

THE FOSTER INSTRUMENT COMPANY, of Letchworth, were showing a series of instruments of considerable interest to foundrymen. The Foster fixed focus radiation pyrometer, shown in operation, performs valuable service in measuring the melting temperatures of iron, steel, brass and other metals. The application may be entrusted to comparatively unskilled operators, as no focussing, colour-matching, or other manipulation is required. The construction of the instrument is robust and simple. For low melting alloys and for annealing work the Foster thermo-electric pyrometers are used. These were shown both as indicating and recording instruments. The use of the Hoskins' alloys of nickel and chromium in place of platinum, and the fact that no porcelain or quartz tubes are employed, ensures an instrument

THE CAMBRIDGE SCIENTIFIC INSTRUMENT COMPANY, LIMITED, Cambridge, also had a fine display of temperature measuring and recording apparatus. Among these may be mentioned resistance pyrometers, working with the Callendar recorder and the Whipple temperature indicator; thermo-electric pyrometers; a Thread recorder, working in conjunction with an automatic triple commutating switch, giving on the chart three independent records of the temperature; various outfits for tool-hardening; and radiation pyrometers, including the standard Féry radiation pyrometer (indicating and recording outfits), the Féry spiral pyrometer, the Whipple-Féry closed tube pyrometer (indicating and recording outfits), and the Féry absorption pyrometer. An automatic furnace regulator worked in conjunction with a resistance pyrometer, the Cambridge extensometer, mark-

ing-off tools, a reading microscope, and a collection of electrical instruments for industrial and scientific requirements were also shown.

On the stand of S. N. Brayshaw, Hulme, Manchester, were shown the Fery pyrometer for high temperatures, a platinum resistance pyrometer and Whipple indicator, a thermo-electric pyrometer connected to a Thread recording instrument giving a continuous temperature record, and a thermo-electric pyrometer connected to a wall-type indicator.

Slots and Grooves cast in.

Slots and Cored-out Work.

Cast Lugs with Holes.

Figs. 7, 8, and 9.—Specimens of Die-finished Castings; by Aerators, Limited.

Die-Finished Castings.

Aerators, Limited, Upper Edmonton, London, N., had on view an excellent selection of their "Prana" alloy die-finished castings. The term "die-finished castings" is a fairly familiar one of late years, but should not be confused with any process of subsequently finishing rough castings by means of special dies. On the contrary, the shape of the article, however complicated it may be, is first of all engraved in segments of solid steel, which form practically indestructible steel moulds or dies, capable of reproducing an almost unlimited number of accurately finished castings. The moulds are then assembled, the metal is forced in

Fig. 6.—The "Foster" Fixed-focus Radiation Pyrometer.

and allowed to set, after which the mould is opened and the finished casting withdrawn. Die-castings have been rather associated with America than with this country, but the exhibits of "Prana" die-finished castings showed that some excellent work is being turned out by Aerators, Limited, The castings made by this firm leave the moulds with finished surfaces of perfect accuracy, the holes, slots, teeth, notches, screw threads, etc. (formerly cut laboriously by a skilled mechanic after the rough sand castings had been marked out and machined), being accurately inserted in the casting process. In recent issues we have dealt with the difficulties in this class of work which have tended to cast disfavour on the process; but "Prana" castings appear to have stood the test of time, and suffer from none of the defects experienced in the earlier days of the trade's development.

An important feature of this process of casting is that the cost of production is reduced by the saving of all coring-out of work, machining of slots and channels, marking out of holes, drilling and template making. Die-finished castings, combining lightness with strength, and being all interchangeable, obviate all difficulty in fitting together a number of small parts. The casting in of very fine threads is not recommended, but all sizes of internal and external threads above 3/16ths inch Whitworth can be cast by the process, being thus made accurately to gauge. Where the casting in of threads is not advisable, holes can be cast (tapping size) in correct position, guaranteed to be the same in each piece.

Fig. 10.—Lever Die-finished Casting; by Aerators, Limited.

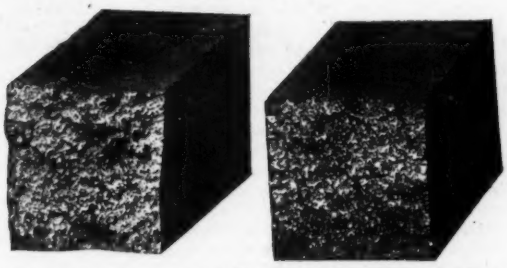


Fig. 11.—Sections of P1 and P4 "Prana" Die-casting Alloys; by Aerators, Limited.

Die-finished castings can be used in place of expensive machined-up brass and iron castings in all automatic machine work, and are especially suitable for such, as they offer great facilities for lightness in construction, at the same time retaining the full strength of the more expensive heavier metals. They are also specially adapted for telephone and electrical instrument work. Component parts of typewriters, gramophones, model aeroplanes,

numbering and counting machines, gas and electrical meters, photographic and microscopical apparatus, spindle bolsters, shuttle eyes, pulleys, and a great variety of other parts are now being made by this process. Castings of gear cases, contact breakers, distributors, switches, speedometers, taximeter frames, hub caps, oil cups, lubricators, and petrol filters and meter castings, bushes in hard and soft metals, etc., have been cast up to 5 or 6 lbs. in weight, and the possibilities of this branch of work are practically unlimited.

The metals employed for this class of work are, of course, an important feature of the process. The "Prana" alloys used by Aerators, Limited, are the company's own specialities, and are guaranteed not to warp or twist after casting. There are several different grades of "Prana" alloys, designated respectively P, P1, P2, P3, P4, P5, their specific gravities varying from 2.6 up to 7.5. The P5 alloy is a special one, which has the advantage of being easily soldered, and is especially recommended for work where it is necessary to solder on wires or connections. Sections of the P1 and P4 alloys are shown herewith. The tensile strength of these has been certified as follows:—P1, 22,680 lbs. per square inch; P4, 13,360 lbs. per square inch.

The Patent Castings Syndicate, Limited, Willesden Green, London, S.W., were exhibiting a fine selection of white alloys, finished ready for assembling. These die-castings are produced by the Doehler process and machine, and well illustrate the possibilities before die-casting. Screw threads, holes, etc., are cast equal to tapping or reaming, while interchangeability is secured with much more certainty than by machining the part, as all cast parts are exactly alike. No fitting work is therefore required, and the pieces only need assembling even when there are several such castings in one piece of apparatus. A special feature claimed for the Doehler process is that, where necessary, brass, steel or other metal pins bushes, tubes, or other such parts, can be cast in. Many parts hitherto considered impossibilities owing to machining difficulties can be readily made by die-casting. Various special metals are used by the firm to meet any unusual condition or strain to which a part may be subjected, thereby making it suitable to perform its function with efficiency. The alloys used cover a large field, such as hard, tough, non-corrosive, anti-friction, steam-resisting, etc., etc., and can be nickelled, brassed, polished, bronzed, or otherwise finished as desired. The firm have a special department for supplying bearings and linings made by their process. They are accurate, have a smooth, perfect finish, equal to the best machined work, and are cast in tough, hard babbitt. If desired, bearings can be cast in any of the special brands of white metal.

Furnaces, Burners, etc.

Alldays & Onions, Pneumatic Enginlering Company, Limited, Birmingham, included in their exhibits their "Empire" oil-fired portable burner outfit, which can be used with advantage for heating ladles, drying moulds, and similar work. For the latter purpose it is particularly suitable, as it can be made to give a smoky flame if wanted, and does away with all the nuisance of moving fires to and from the foundry. The burners are also used for cupola lighting, and where wood is scarce or expensive, prove much cheaper than the old method. For repairing castings these burners are very well adapted, as by their use it is possible to raise to a welding heat the parts to be repaired or burned on, and all that is necessary is to place the two parts together and pour the iron on, when it will stick fast at once, and so do away with the necessity of pouring the hot iron on to the two joints for a considerable time, whereby is wasted a great deal of time and metal. In support of this it may be mentioned that it is quite possible to melt an ordinary casting by means of this burner; it will easily melt a piece of iron of 3½ in. by 2½ in. thick placed in the open on the ground in twelve minutes.

For pipe bending, too, the Empire burner outfits are very useful. They afford three distinct advantages, as the pipe has not to be moved in and out of the forge, the handling of the pipe while being heated is done away with, and lastly, the carrying of the heated pipe to the bending plate, during which process a great deal of the heat obtained is lost, is obviated, as it is only necessary to place the pipe to be heated in position on the bending plate and heat while in position.

Fig. 12.—"Empire" Portable Burner Outfit, Compressed-air Type, for Oil Fuel.

Pattern No. 07, compressed-air style, of this burner, for use when high pressure is available, is shown in Fig. 12. This consists of a galvanised oil tank, complete with gauge for registering the measure. To work satisfactorily it must have a pressure of at least 5 lbs., and anything to 40-50 lbs. per square inch. There are several other patterns, No. 08 being similar to the above, and supplied complete with an air pump built in the tank, by means of which a pressure for giving a lead to the oil is obtained. The pressure must be at least 10 lbs. to work satisfactorily, and anything up to about 40 lbs. The tank is fitted with a pressure gauge. For supplying the burner with air pressure, an ordinary positive-pressure blower is used, and need not be at more than 1½ lbs. pressure (the firm's No. 4 "Empire" positive pressure blower is a suitable apparatus). Both the above outfits are suitable for burning creosote or ordinary crude oil, and are made for holding 10 gallons of oil each, and also made with double burners for heavy work. Another pattern, No. 3, is an independent self-contained style, and

supplied with a hand pump attached to the tank. Only kerosene oid or paraffin can be used, and to operate it is only necessary to fill the tank with fuel and pump air into the tank until about 10 lbs. of air pressure is shown at the indicator, and then the burner can be started. The above is very suitable when compressed air is not available, such as for outdoor work, etc., and can be used for the same purpose as the other types.

A selection of Root's blowers and "Duplex" blowing fan for cupolas and similar work were further shown on this firm's stand. Alldays' "Duplex" fans have already been described in our columns.

S. N. Brayshaw, Hulme, Manchester, among their exhibits were showing various hardening and other furnaces, fitted with the firm's patent gas burner. A salt-bath furnace, with rising and falling tray; a 60-lb. crucible furnace, suitable for melting brass, copper, nickel, etc.; a case-hardening and annealing furnace; a twin-chambered furnace for hardening high-speed steel, fitted with improved sliding doors and table; and a small size of twin-chambered furnace, for hardening high-speed lathe and other small tools were on view. A number of these furnaces were shown in operation. The crucible furnace which was shown, fitted with Brayshaw gas burners, is suitable for melting aluminium, brass, bronze, copper, iron, nickel, and other metals. The furnace is lined with special refractory material, surrounded by a great thickness of lagging to retain the heat and economise gas. A stock is kept of spare linings, which are easily placed in position and save the time of rebricking, whilst they ensure the furnaces being correct. The furnace is very strongly built in steel frames, and is provided with an inlet block, slag hole, outlet damper, cover, etc., complete. The furnace is equipped with Brayshaw burners, which have been adopted at the Royal Mint, in London. The Official Report for 1910 states that the use of gas in connection with the Brayshaw burner has effected an economy over coke of 29 per cent. in fuel alone, whilst the crucibles last 50 per cent. longer. The burner is applicable to producer gas. Temperatures up to 1,300 deg. C. can be obtained in these furnaces with gas of 150 B.T.U. Compressed air is required for the burners, the pressure being only 1 lb. or 2 lbs. per sq. in., and the noise is so slight as to be unobjectionable. The labour connected with these furnaces is very much less than when coke is used. The melting is rapid, and the heats are under the most perfect control.

James Keith & Blackman Company, Limited, London.—An imposing display of this Company's plant was made, including "Keith" steel plate blowing and exhausting fans, induced and forced draft for boilers and dust extraction. The Company's open-type fans for handling large volumes of air against comparatively low resistances, suitable for ventilating engine rooms, etc., were shown, and also their high-pressure fans suitable for furnishing blast for cupolas and furnaces, gas producers, etc. The well-known "Keith-Blackman" air propellers, box blade and reversible types, and smiths' hearths fitted with self-contained water bosh and electrically-driven blower were further items; while the Keith light (high-pressure gas), too, was exhibited, the installation comprising an electrically-driven gas compressor, supplying gas under pressure to "Keith" inverted lamps.

Welding Plants.

The Messer Engineering Company, London.—An exhibit of considerable interest was shown by this firm, in the form of autogenous welding and cutting plants, including blowpipes, regulating valves, stationary and portable acetylene generators, hydraulic back-pressure valves, etc. An exceptionally fine collection of samples of work done with the "Messer" appliances, such as artistic metal work for iron gates, railings, etc., and samples of welding of wrought iron, sheet iron, cast iron, steel, copper, nickel, aluminium, and other metals, well illustrated the adaptability of the process. Further to that, practical demonstrations were given at the stand in welding and cutting various metals.

Carbic Limited, London.—This firm were also showing oxy-acetylene welding and cutting apparatus; permanent and portable lighting plants, etc., and "Carbic," a specially prepared and treated carbide compressed into cylindrical cakes of various sizes by a process whereby every particle of carbide is rendered impervious to atmospheric moisture, and susceptible only to the action of water. In the welding apparatus shown, various processes connected with oxy-acetylene work were demonstrated, whilst a wide range of lighting apparatus for various purposes was exhibited.

The National Health Insurance Commission (England) notify that persons employed under a contract of apprenticeship must be insured under the National Insurance Act, 1911, unless employed without money payment. Where money payment of any kind is made to an apprentice *in respect of his employment*, the apprentice is required to be insured. It does not matter whether the money payment is in the nature of fixed wages paid at stated intervals or not; but there must be some sort of regularity or continuity in the payment, or it must, at any rate, bear some relation to the period of employment (or some considerable portion of it) as a whole, as distinguished from casual payments at particular times or in connection with some particular piece of work. Thus an uncertain sum derived from commissions on sales and paid (even though at irregular intervals) throughout the whole year would be a "money payment"; but payments in the nature of gratuities which the employer is not legally bound to make under the terms of any contract express or implied are not sufficient to make the apprentice insurable, such as a bonus at the end of the year or an allowance of pocket money. If, however, as is sometimes the case, the payment of the bonus, or pocket money, or of such a commission, is a term of the contract between the apprentice and his employer, this is a "money payment," and the apprentice must be insured. In some cases the payment may take the form of the return in instalments of a premium paid at the beginning of the apprenticeship; and in such circumstances, if the instalments are repaid to the apprentice himself or to some other person on his behalf, he is insurable; though it would be otherwise if the instalments were repaid to the person who originally provided the premium for his own use and benefit. An apprentice to whom the Act applies, as above, if he can prove that he is either—(a) in receipt of an income of £26 a year or upwards not dependent upon his personal exertions, or (b) ordinarily and mainly dependent for his livelihood upon some other person, may claim a certificate of exemption under Section 2 of the Act. The grant of such a certificate will not, however, relieve the employer from the obligation to pay his own portion of the contributions in respect of the apprentice. In the case of employed persons under the age of 21 the contributions are always at the standard rate, whatever the rate of remuneration may be.

Inventions.

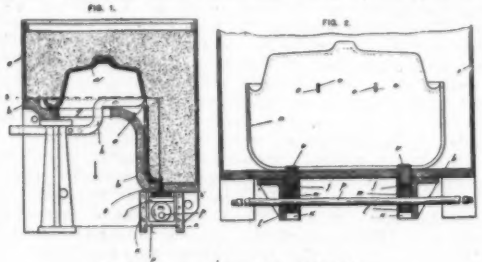
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

21,019. Moulding machine. W. D. Oddy.
21,281.*Electric furnaces. E. Stassano
21,290.*Electric furnaces. J. M. Bocuze.
21,560. Smelting-furnaces. T. H. Holroyd.
21,738.*Solidifying molten steel in casting into ingots. Barthold Gerdau.
22,382. Construction of fire-grates of muffles and furnaces and secondary air bricks therefor. W. P. Gibbons, G. B. A. Gibbons, R. Masters, and T. V. Dann.
22,427.*Manufacture of steel. J. Fattelay (*dit* Victor).
22,532. Metallic alloys. J. F. Duke.
22,561. Electric furnaces. (General Electric Company, United States).
22,564. Heating furnaces. G. B. Wright.
22,607. Casting machines for making die castings. J. R. Vellacott.
22,610. Melting lamps, soldering and coating apparatus. T. Grundy.
22,661. Moulding flasks or boxes. (Percy Webster, United States).
22,694. Furnaces. J. A. Rollinson and S. Rollinson.
23,739. Manufacture of steel. H. Eccles and R. P. Bevan.

Abstracts of British Patent Specifications recently accepted.

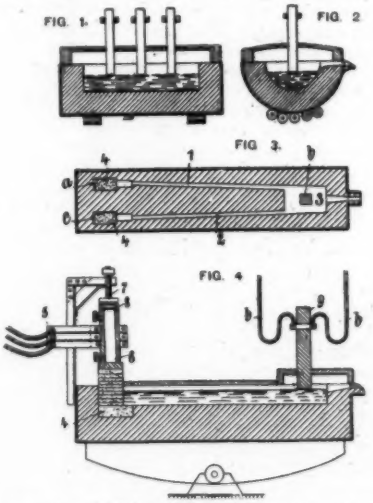
6,742 (1912). *Patterns for Foundry Moulding.* E Pipher, King Street, Port Hope, Ontario, Canada, foundry superintendent for the Standard Ideal Company, Limited.—Fig. 1 is a vertical section through the pattern showing the movable pattern members, flask and moulding sand; Fig. 2 is a vertical section taken at right angles to Fig. 1. The pattern *a* is fixedly attached to the pattern block *b* which, during the formation of the mould, forms the false part of the flask. In the preparation of the mould, the flask *o* is placed around the pattern *a*, the bottom of the flask being seated upon the



Patterns for Foundry Moulding.

pattern block. The moulding sand is then placed in the flask, and the flask and pattern are jarred vertically, as indicated by arrow in Fig. 1, until the moulding sand is packed tightly around the pattern to form an imprint in exact correspondence of the external surface of the pattern *a*. When the imprint of the external surface of the pattern is made, a movable pattern member *c*, located above the pattern block, is projected through an aperture in the wall of the pattern *a* to enter the sand and complete the formation of the mould cavity by forming in the moulding sand the imprint for the casting of the projecting lug of the metal body. For the operation of the movable pattern member *c* there is formed in the pattern *a* a slot *e*, and in the pattern block *b* a slot *g*, the end of the slot *g* engaging with a bent portion *h* of the movable pattern member, to limit its outward movement beyond the surface of the pattern *a* for the completion of the mould. When the mould is formed, the movable pattern member is retracted until it is wholly within the surface of the pattern *a* for the drawing of the pattern from the flask. By this means one is able, by jarring or vibrating the pattern and flask, to mould an imprint of the pattern *a* and then mould an imprint of the movable pattern member or members angular to the line of impact resulting from the jar or vibration, and also, upon the retraction of the movable pattern member or members within the pattern *a*, to effect the separation of the mould from the pattern without injury to the imprint.

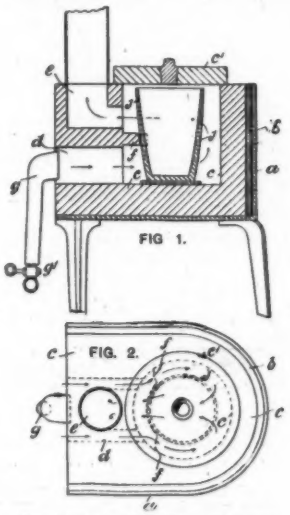
20,121 (1911). *Process and Furnace for Melting Ferro-manganese, etc.* J. I. Bronn, 3, Vorstadtstrasse, Rombach i/Lothringen, Germany.—Figures 1 and 2 are vertical cross sections at right angles to each other of a furnace for three phase current; Figures 3 and 4 are respectively a sectional plan and a sectional elevation of a modified construction of furnace. The furnace shown in Figs. 1 and 2 is designed for three-phase current; it is similar in its construction to the usual steel furnaces and like these it can also be operated with ordinary alternating current, that is to say with only two electrodes. It is, however, indispensable that the



Furnace for Melting Ferro-Manganese and other Ferro-Alloys.

voltage drop between each electrode, and the belt shall not exceed certain limits. This can be easily effected by arranging that the source of current to which the electrodes are to be connected shall supply a current of suitable low voltage. In most cases the current can be supplied by stationary transformers. When, for instance, a single phase electric furnace having only one contact resistance between the movable electrode and the metal bath is required to work with a voltage drop of about 20 volts, then the voltage between the secondary terminals of the transformer must not exceed 20 volts (including any loss of voltage). In single phase furnaces having two movable electrodes, the voltage drop between each electrode and the metal bath must amount to 20 volts as before, and therefore the voltage between the two secondary terminals of the transformer must be $20 \times 2 = 40$ volts. In three-phase furnaces having three movable electrodes as shown in Figs. 1 and 2, the voltage between every two secondary terminals of the transformer installation must be made equal to $20 \times \sqrt{3} = 20 \times 1.74 = 34.3$ volts. This discovery that by a kind of heating by contact resistance it is possible to obtain a supply of heat which is quite sufficient for melting and keeping in the molten state ferro-manganese and the resulting slag, may be applied directly to a furnace of the type illustrated in Figures 3 and 4.

12,402 (1912). *Gas Heated Crucible Furnaces.* Fletcher Russell & Company, Limited, and T. W. Fletcher, Palatine Works, Warrington.—Fig. 1 is a vertical section, and Fig. 2 a plan, of the improved furnace. The invention consists in placing within a metal casing *a* that is lined with asbestos *b* a fireclay shell *c*, that is provided with an inlet *d* for gas and an outlet *e* for the spent gases. A horizontal baffle *f* is provided between the inlet and outlet passages *d* and *e*, and fit at or near the inlet



Gas-heated Crucible Furnace.

passage *d* an atmospheric burner *g* of ordinary construction with a gas tap g^1. Within the fireclay shell *c* is placed a crucible *j*, which is enclosed by means of a cover c^1. The flames from the gas which enters at the inlet *d* under any pressure are caused to pass around the base and up the sides of the crucible *j* by the horizontal baffle *f*, then returning around the upper portion of the crucible *j*, the spent gases passing through the outlet *e*, thereby utilising to the fullest extent the products of combustion.

20,204 (1911). *Treatment or Renovation of Foundry Sand.* A. Poulson, Hope House, Farnworth, near Widnes; and Poulson's Foundry Specialities, Limited, 7, East Parade, Leeds.—It is proposed to use calcium chloride, sodium chloride, magnesium chloride, or any suitable chloride in combination with sulphate of alumina for the purpose of renovating the spent sand. The renovator is prepared in two stages. A mixture of sulphate of alumina and water being first obtained to which is then added the chloride. Suitable proportions that have been found to answer well in practice are 3 lbs. of sulphate of alumina, incorporated with 2 lbs. of water, and ground up well together. To this mass is then added a mixture consisting of 3 lbs. of magnesium chloride and 3 lbs. of sodium chloride, which have been well mixed together. The renovator mixture thus obtained is incorporated with the sand either in a dry state and water subsequently added, or the chlorides and sulphate of alumina may be diluted with water, and this diluted mixture subsequently incorporated with the sand. It is found that a suitable proportion for this renovator mixture is about 3¼ to 5 tons of renovator per 100 tons of sand to be renovated according to the nature of the sand.

Messrs. Douglas & Grant, of the Dunniker Foundry, Kirkcaldy, have converted their business into a private limited company, under the name of Douglas & Grant, Limited. The board of directors of the company consists of Mr. Lewis Grant (chairman), and Messrs. David Landale, Charles Edward Douglas, Lewis Campbell Grant, and Andrew Ness.

Legal.

Sheffield Castings in Dispute.

An important action was started at the Sheffield County Court, recently, when Cammell, Laird & Company, Limited, claimed from Messrs. Owen, Isaac & Owen, Portmadoc, Carnarvon, for £76, balance of an account for £118.

Mr. T. E. Ellison, who appeared for the plaintiffs, said the only items in dispute were with respect to castings supplied. These were gear wheels required for the transmission of power from an electric motor to haulage plant in a quarry, and it was alleged that these were of a material unsuitable for the purpose, and as a result very soon showed the effects of wear.

Mr. Neal, for the defendants, elicited from the manager of the quarry that the power transmitted varied from 90 to 100 horse-power, and after a few weeks the gear showed such serious signs of wear that he discontinued their use; another set supplied wore as badly. The first set were in use only 61 working days, and the second set 21 days. In his experience such gear should have a normal life of from 15 to 20 years. It was true that the teeth of the gear had not been lubricated, but other electric gear in use since 1903 had not been lubricated, and in his opinion the absence of lubrication would not affect by more than 10 per cent. the life of such gear.

A member of the defendant firm said the analysis of drillings from the gear wheels as reported by the Yorkshire Testing Company, of Sheffield, showed 0.24 carbon, which in his opinion showed the steel to be too soft for the purpose.

Mr. Henry Bolsover, managing director of the Yorkshire Testing Company, proved the analysis and said steel of such constituents was in his opinion too soft for gears carrying a load of 150 horse-power at 500 revolutions per minute, as specified in the defendants' order.

Mr. Thomas Davies, of London and Liverpool, consulting engineer to the Liverpool Corporation, gave similar evidence.

Mr. John Little, M.I.Mech.E., general manager of Messrs. Cammell, Laird & Company's Grimesthorpe Works, said, in his opinion, based on 35 years' experience, the gears were made of material absolutely suitable for the purpose. The effect of no lubrication on gears running at 500 revolutions a minute was that the material was ground away. The firm's average output of gearing was 500 tons a year, mostly of similar composition to that supplied to defendants. He attributed the undue wear to the want of lubrication and improper braking.

Mr. John Watson, manager of Messrs. Cammell, Laird and Company's steel foundry, gave evidence to a similar effect.

The hearing was adjourned.

Mr. R. Hudson, J.P., managing director of the Lion Foundry Company, Limited, who died recently, left personal estate in the United Kingdom valued at £3,800.

The gross value of the estate of the late Mr. Wm. Jackson, of Messrs. Jeremiah Jackson & Sons, engineers and machine makers, Todmorden, and a director of Meters, Limited, is £1,877, with net personalty £1,485.

Mr. Harry Brearley, of the Brown-Firth Research Laboratory, Sheffield, has been appointed examiner in iron and steel manufacture to the department of Technology of the City and Guilds of London Institute. Mr. Brearley is well known in Sheffield as a metallurgist and to a wider circle as the author of books dealing with the investigation and treatment of steel.

Mr. A. E. Doxford, a director of Wm. Doxford & Sons, Limited, engineers and shipbuilders, of the Pallion Iron Yard, Pallion, Sunderland, who represented the engineering industry on the Boats and Davits Committee of the Board of Trade, has resigned that position. He will be succeeded by Mr. D. B. Morison, managing director of Richardsons, Westgarth & Company, Limited, of the Hartlepool Engine Works, Hartlepool.

Trade Talk.

THE London office of Dorman, Long & Company, Limited, has been removed to 110, Cannon Street, E.C.

THE HULBURD ENGINEERING COMPANY, LIMITED, have removed to St. Benet Chambers, Fenchurch Street, London, E.C.

IN future the Lambeth Brass and Iron Company, Limited, Southwark Street, London, S.E., will be known as Lamberts, Limited.

MR. N. K. TURNBULL has established himself in business at 3, York Street (Parr's Bank Buildings), Manchester, as a consulting engineer.

F. W. BRACKETT & COMPANY, LIMITED, of the Hythe Bridge Ironworks, Colchester, have been placed on the list of contractors to the India Office.

A DESTRUCTIVE fire broke out at the works of Elliott's Metal Company, Limited, Selly Oak, Birmingham, on October 19, doing considerable damage.

A FIRE occurred recently at the Apollo Works, Moseley Street, Birmingham, of Thos. Crosbee & Sons, brassfounders, the damage being considerable.

A. A. JONES, POLLARD & SHIPMAN, LIMITED, will in future be known as A. A. Jones & Shipman, Limitad, of the New Century Works, East Park Road, Leicester.

THE partnership heretofore subsisting between Messrs. G. A. Boshier and W. E. Judge, carrying on business as engineers, at Bidford-on-Avon, was dissolved on September 30.

THE VERNON ENGINEERING AND CARRYING COMPANY, LIMITED, is being voluntarily wound up, with Mr. J. A. Hardie, Holly Grove, Hipperholme, near Halifax, as liquidator.

AT the public examination in bankruptcy of Mr. Bernard Musgrave, a director of the firm of John Musgrave & Sons, Limited, Globe Ironworks, Bolton, a deficiency was reported of £49,165 10s. 11d. net, the assets being £762 16s.

HERBERT MORRIS, LIMITED, of the Empress Works, Loughborough, have established offices in the Standard Buildings, City Square, Leeds, and 30, George Square, Glasgow. An office will also be opened in Birmingham shortly.

THE trustee of the sequestrated estates of J. R. Davidson & Company, engineers, etc., 116, Hope Street, Glasgow, and James Ramsay Davidson, the sole partner of that firm, intimates that a first dividend will be paid on November 22.

MESSRS. J. C. B. RICHARDS and G. E. WILKINS, carrying on business as engineers, at Moxley, Wednesbury, under the style of the Moxley Manufacturing Company, have dissolved partnership. Mr. G. E. Wilkins will continue the business.

HARLAND & WOLFF, LIMITED, of Belfast, are stated to have disposed of the Govan Works of the London and Glasgow Engineering and Iron Shipbuilding Company, Limited, to the Burmeister and Wain (Diesel System) Oil Engine Company, Limited.

THE South African representation of Samuel Osborn & Company, Limited, has been vested in Mr. W. Raeburn Srow, who for many years past has been the representative of the firm, in conjuncton with their agents, Messrs. William Hosken & Company, Johannesburg.

MR. L. V. BERTRAND, of West Bromwich, brass and iron founder, trading with H. P. F. F. Bertrand and J. H. Bertrand, as P. H. Bertrand & Son, will make an application for his discharge from bankruptcy at the West Bromwich Court on November 22 next.

MR. W. L. SHAKESPEARE, pattern maker and engineer, carrying on business under the style of Shakespeare, Belt & Company, Fornham Works, Suffolk Road, Sheffield, is paying a first and final dividend of 4s. 4½d. in the £ at the Official Receiver's Offices, Sheffield.

THE firm of Hugh Martin & Sons, Coatbridge Iron Works, Coatbridge, of which Mr. Hugh Martin and Mr. John Munro Martin were the sole partners, was dissolved as at December 30, 1911. The business has now been taken over by the Scottish Iron and Steel Company, Limited.

THE shareholders of the Wade Engineering Company, Limited, will meet at 6, Castle Street, Liverpool, on November 14, for the purpose of considering the liquidator's accounts, showing the manner in which the winding-up has been conducted and the property of the Company disposed of.

AT a general meeting of the shareholders of Thomas Ellis, Limited, North British Iron Works, Coatbridge, held on September 10, a resolution was passed to the effect that the company be wound up voluntarily. Mr. D. S. Carson, 209, West George Street, Glasgow, was appointed liquidator.

A SERIOUS fire broke out on October 18 at the Britannia Works, Banbury, belonging to Samuelson & Company, Limited. The carpenters' shops were completely gutted, and a large quantity of machinery damaged. The operations of the company, however, will not in any way be interfered with.

THE partnership heretofore subsisting between Messrs. T. D. Merton and H. MacKenzie Ridge, carrying on business as makers and vendors of furnaces for roasting ores and other materials, at 62, London Wall, London, E.C., under the style of the Merton Furnace Company, has been dissolved.

THE METROPOLITAN CARRIAGE, WAGON AND FINANCE COMPANY, LIMITED, of Saltley, Birmingham, have removed their London offices, including those of the Patent Shaft and Axletree Company, Limited, from 36, Victoria Street, Westminster, S.W., to Brunswick House, Central Buildings, Westminster, S.W.

THE partnership heretofore subsisting between Messrs. H. P. Saunderson and A. V. Gifkins, carrying on business as engineers and ironfounders, at Elstow Works, Bedford, under the style of Saunderson & Gifkins, has been dissolved. The business will be carried on in future by Saunderson & Mills, Limited.

NOTICE is given that a meeting of the members of the Magnum Steel Company, Limited, will be held at St. Helens, on Monday, November 11, for the purpose of having an account laid before them, showing the manner in which the winding-up has been conducted and the property of the company disposed of.

THE partnership heretofore subsisting between Messrs. H. Haggas, Joseph Ward, C. W. Smith, F. T. Haggas, W. Haggas, and John Ward, carrying on business as machine tool makers, at Keighley, under the style of Ward, Haggas & Smith, has been dissolved, so far as concerns Messrs. Joseph Ward and John Ward.

J. HOPKINSON & COMPANY, LIMITED, of Huddersfield, are laying down a steel foundry at the rear of their Britannia Works, included in the equipment of which will be a 2-ton Stock oil-fired converter. The whole of the foundry auxiliaries will be electrically operated. To meet the demand in this direction, and also the call for additional power in other portions of the works, a further Parsons turbo-generator of 600 kw. capacity is to be installed in the works power-house.

WE understand that the Plaskynaston Foundry, near Ruabon, which was recently put up for sale by auction, but which was withdrawn on account of a sufficiently high price not having been bid, has now been bought privately by a number of gentlemen, prominent among whom is Mr. T. Longdin, of Ruabon, who is well known in the engineering industry. It is a well-equipped foundry, and situated conveniently close to the railway station, and also on the banks of the Shropshire Union Canal.

THE annual meeting of the Birmingham section of the Institute of Metals was held on October 22. Professor Turner was appointed president in place of Mr. Boeddicker, who resigned the office. It was reported that the membership was now 76, including 22 associates. Professor Turner, in his presidential address, said that the result of the first year's work of the local section of the Institute had been very gratifying. A good metallurgist required many qualifications beyond his scientific training—such as practical experience, commercial know-

ledge, tact, and industry. He was confronted, on the one hand, with problems dealing with large outputs, mechanical handling, rapid transit, the standardisation of patterns, and huge capitalisation. On the other hand, the metallurgist had to deal with the microscope or ultra-microscope in connection with the properties of metals, and the effect of minute pieces of impurities or of changes of temperature upon these properties.

As briefly notified in these columns some time back, the Stobie Steel Company, whose business is temporarily housed in Foster's Buildings, High Street, Sheffield, are building a new steelworks in which all the melting and further treatment of the steel will be electrical. This will be the first large steelworks in Great Britain solely engaged in the electrical manufacture of tool steels, alloy steels, and similar products. The new works are being erected on Tyneside as, we understand, current can be obtained on the North East Coast under more favourable conditions than in Sheffield. The installations will, at first, consist of a 15-ton three-phase steel melting furnace, a 5-ton two-phase furnace for special steels, and a 3-cwt. alloy melting furnace. All these furnaces are being designed and built by Mr. Victor Stobie. We understand that a 2-ton Stobie patent electric steel melting furnace is shortly being built for another Sheffield steelworks, and a 15-ton furnace is also projected for a steelworks in the North.

A large number of metallurgists gathered at the Swansea Technical College, recently, on the occasion of the inaugural meeting of the Metallurgical Society for Swansea and District. The chair was taken by Colonel Alex. Sinclair, A.M.I.E.E., who, in introducing Professor Turner to the meeting, referred to the importance of Swansea as a metallurgical centre, not only in smelting operations and the production of virgin metals, but in a newer and growing industry, viz., the mixing of metals. Birmingham was the great centre of this latter industry, but Swansea also produced alloys, and there was every promise of still further development. In his address, Professor Turner pointed out the great advantages which would accrue not only to its members, but to the town and district, by the formation of a Metallurgical Society. He instanced the diffusion of scientific knowledge, the wider outlook obtained by the exchange of ideas, the social advantages, and the facilities afforded for the meeting of members and for discussion with those who represented different, but closely-allied, branches of industry. He emphasised the necessity of establishing the society on a broad basis so as to include all interested in metals, ores, ore-concentrating, and in fuel and refractory materials, metal smelters and refiners, engineers who employed metals, merchants who distributed them, and assayers and scientific experts, who analysed and tested them.

A scheme for the development of the iron industry in New Zealand is being put forward on behalf of a group of capitalists in London by Mr. J. H. Witheford, who has returned to the Dominion after an absence of several years in London. Mr. Witheford has apparently secured the co-operation of the Ethelburga Syndicate, Limited, to develop the New Zealand iron industry. Mr. Witheford has forwarded a letter to Mr. Massey, the present Prime Minister, explaining in brief the proposals that the syndicate wishes to put before the Government of New Zealand. As regards the subsidy question, it is proposed that:—(a) In lieu of all bonuses proposed to be given to the iron industry that a direct annual subsidy of £32,500 should be given, and that the investors should erect modern iron and steel works, at a cost of £650,000, and thus enable the New Zealand works to take fuller advantage of local and foreign markets. (b) The State is to get its iron and steel at cost price, plus 5 per cent. (c) Arrangements will be made to use State-mined coal and coke, if price and quality are satisfactory. (d) At the end of 40 years the company is to hand over to the Dominion Government the whole plant and all the machinery erected by them, free of any charges. or (e) under certain equitable conditions. at the end of 20 years. As our readers know, the New Zealand iron industry has been a favourite field of the company promoter for years past. Up to the present, of the many schemes proposed, none has ever developed.

New Companies

Ironite, Limited.—Capital £2,500 in £1 shares. Registered office: 25, Victoria Street, S.W.

H. D. R. Welding and Engineering Company, Limited.—Capital £5,000 in £1 shares.

Works Control, Limited.—Capital £150 in £1 shares, to carry on the business of engineers, etc.

Joint Standard Union, Limited.—Capital £3,000 in £1 shares, to acquire pipe joint inventions.

James Widnes, Limited.—Capital £3,000 in £1 shares, to carry on the business of metallurgists, etc.

Sawyer & Dyer, Limited.—Capital £3,000 in £1 shares, to carry on the business of engineers, etc.

R. Gibson & Company, Limited.—Capital £4,000 in £1 shares, to carry on the business of engineers, etc.

Gibbons (Australasia), Limited.—Capital £15,000 in £1 shares, to carry on the business of engineers, etc.

Hecco Developments, Limited.—Capital £100,000 in £1 shares, to carry on the business of engineers, etc.

D. J. Smith & Company, Limited.—Capital £3,500 in £1 shares, to carry on the business of engineers, etc.

T. Davies, Limited.—Capital £15,000 in £1 shares (5,000 preference), to carry on the business of iron-founders, etc.

Clement, French & Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of mechanical engineers, etc.

E. F. Blakeley & Company (Liverpool), Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc.

Advisory Engineers Corporation, Limited.—Capital £6,000 in £1 shares. Registered office: 11, Tothill Street, Westminster, London S.W.

Invicta Engineering Company, Limited.—Capital £5,000 in £1 shares. Registered office: 61, The Broadway, Bexley Heath, Kent.

Planters' Engineering Company, Limited.—Capital £5,000 in 4,950 preferred ordinary shares of £1 and 1,000 deferred ordinary shares of 1s.

Lindsay's Paddington Ironworks, Limited.—Capital £12,000 in 5,000 preference shares of £1, 16,000 ordinary shares of 5s., and 3,000 preference shares of £1.

Douglas & Grant, Limited.—Capital £60,000 in £1 shares, to acquire and carry on the business of Douglas & Grant, engineers. Registered office: Dunniker Foundry, Kirkcaldy.

Germain Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of general engineers, etc. Registered office: 1-2, George Street, Mansion House, E.C.

Pattern Requisites, Limited.—Capital £1,000 in £1 shares, to take over the business of pattern makers and factors carried on at 24, Branston Street, Birmingham, as Stampe & Fletcher.

George Thornton & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of edge tool makers. Registered office: Phœnix Works, Wharf Street, Aston, Birmingham.

Neilson & Cleland, Limited.—Capital £20,000 in £1 shares (6,000 preference), to carry on the business of iron, steel, and metal merchants and founders. Registered office: 122, Main Street, Coatbridge.

The Apex Steel Company, Limited.—Capital £10,000 in £1 shares, to take over the business of a steel manufacturer and merchant, formerly carried on by Mr. T. Inman, as the Apex Steel Company. Registered office: 17, Attercliffe Road, Sheffield.

R. S. Allan & Company, Limited.—Capital £3,000 in £1 shares, to carry on the business of patentees and manufacturers of and dealers in woodworking, metal working, and other machinery, etc. Registered office: Redheugh Bridge Road, Gateshead.

W. H. Briscoe & Company, Limited.—Capital £5,000 in £1 shares, to acquire the business of stampers, piercers and brassfounders carried on by A. C. Briscoe and E. C. Briscoe, at Cox Street, St. Paul's Square, Birmingham, as W. H. Briscoe & Company.

Personal.

LORD FURNESS has resigned his position as chairman of Palmers Shipbuilding and Iron Company, Limited.

MR. H. J. SILLARS, secretary of the Glengarnock Iron and Steel Company, Limited, has been made a J.P. for Ayrshire.

MR. P. A. SANDERS, A.M.I.Mech.E., has been elected a director of Davey, Paxman & Company, Limited, Colchester.

THE net value of the estate of the late Mr. T. R. J. Logan, chairman of William Dixon, Limited, is £161,181 7s. 6d.

THE late Mr. J. P. Wilson Walker, of the Dalmellington Iron Company, Limited, left personal estate in the United Kingdom valued at £26,398.

THE late Mr. Thomas Boswell, of Messrs. Thos. Boswell & Company, steel and file manufacturers, of Bath Street, Sheffield, left estate valued at £1,481 gross.

MR. W. H. DONNER, who is well-known in the American steel trade, has been elected president of the Cambria Steel Company, in place of Mr. C. S. Price, resigned.

THE gross value of the estate of the late Mr. William Shakespeare, who formerly carried on the Trent Ironworks, is £52,532 gross, with net personalty £49,681.

MR. G. R. RICHMOND, of G. & J. Weir, Limited, Holm Foundry, Cathcart, has been elected Deacon of the Hammermen's Incorporation of the Trades House of Glasgow.

MR. HERBERT BATES has been elected managing director of Hulse & Company, Limited, Ordsal Works, Regent Bridge, Salford, Manchester, in the place of the late Mr. Edwin Adams.

MR. G. H. BANISTER, who for a few years has been manager of the engineering department at the Barrow works of Vickers, Limited, has been appointed a local director of the firm.

MR. W. T. COX, A.M.I.C.E., who is on the engineering staff of Cammell, Laird & Company, Limited, has just been appointed assistant Government engineer at the Government factory in Colombo.

THE late Mr. William Graham Vivian, of the firm of Messrs. Vivian & Sons, Hafod Copper Works, Hafod, near Swansea, left estate valued for probate at £1,000,000 so far as at present can be ascertained.

THE late Mr. Thomas Bright Matthews, lately of Turton Bros. & Matthews, Limited, Sheffield, who died on May 30 last, aged sixty-eight, left estate of the gross value of £123,164, with net personalty £121,890.

MR. ROSSITER HOYLE, the new Master Cutler of Sheffield, was installed at the Sheffield Court House on October 4. Mr. Hoyle is the managing director of Thomas Firth & Sons, Limited, of the Norfolk Works, Sheffield.

MR. J. O'CONNOR, assistant manager of the Siemens' Department of the works of Messrs. John Brown & Company, Limited, has been the recipient of a presentation from the officials and men on the occasion of his marriage.

MR. C. VERNON, eldest son of Mr. John Vernon, a director of Wm. Heaton & Company, Limited, Millmoor Brass Works, Rotherham, has just reached his majority, and the event was celebrated by a presentation from the officials and men.

IT is announced that Mr. Alfred Shuttleworth has accepted a seat on the board of directors of the Lincoln Wagon and Engine Company, Limited, and that Mr. Arthur C. Newsum has been elected chairman of the company in place of the late Mr W. T. Page.

MR. JOHN MACKAY, of Messrs. Alder & Mackay, engineers, of the New Grange Works, Gorgie Road, Edinburgh, is just recovering from a serious illness, but a further prolonged absence from business will probably be necessary before Mr. Mackay is quite convalescent.

MR. WILLIAM FODEN, a director of Fodens, Limited, engineers, Elworth Works, Sandbach; MR. EDWIN WOODS, Rock Villa, Latchford, wire manufacturer; and MR. JOHN ALFRED RANSOME, joint managing director of the Richmond Gas Stove and Meter Company, Limited, have been appointed J.P.'s for Cheshire.

THE following changes have taken place on the Council of the Iron and Steel Institute, consequent on the death of Mr. W. H. Bleckly, hon treasurer:—Mr. W. Beardmore, vice-president, has been appointed hon. treasurer, and Mr. J. M. While, member of council, has been elected a vice-president, to fill the vacancy thus created. Lord Airedale of Gledhow has been elected a member of council in lieu of Mr. While.

MR. HEGGIE, on the occasion of his retiral from service with Carron Company, after a connection extending over the long period of 58 years, was the recipient, last month, of a presentation by his fellow-workers and friends. Mr. George Pate, assistant manager at the Carron Works, occupied the chair, and the presentation, which consisted of a barometer and a walking stick, along with a gold brooch and pendant for Mrs. Heggie, was made by Mr. Allan, a departmental manager, who said they all regretted Mr. Heggie's departure from their midst, and hoped he would be long spared to enjoy his well-earned retirement. In the course of his reply, Mr. Heggie said that in retiring from active work he was severing a connection between his family and Carron Company which

MR. HEGGIE (FALKIRK).

had existed for 119 years. His grandfather entered the service of the company in 1793, and since then there had always been members of his family in their service. He himself had been 58 years with Carron, during 38 of which he had held the position of foreman patternmaker. He had served under seven managers. Many changes had taken place in his time. New works had been built, extensions had been made, new blast furnaces had been constructed, time and labour-saving tools had been introduced, and improvements of all kinds had taken place. Competition was now so keen that no firm could afford to neglect, but must take full advantage of all the skill, science, and inventions of modern times at their command.

MR. J. F. L. CROSLAND, chief engineer to the Vulcan Boiler and General Insurance Company, Limited, has resigned that position owing to advancing years. He will retain a connection with the Vulcan Company as consulting engineer. The directors of the company have appointed Mr. C. Bullock to be chief engineer, in succession to Mr. Crosland, and Mr. J. C. H. Crosland and Mr. F. H. Bullock to be assistant engineers.

PROFESSOR HUNTINGDON has been elected president of the Institute of Metals for the ensuing session, with Mr. Johnson and Professor Turner as vice-presidents, and Messrs. A. Barr, G. T. Beilby, C. H. Wilson, Clive Cookson, A. Philip, and Sir William E. Smith as members of council. Professor Gowland relinquished the presidency in consequence of the state of his health, while Mr. J. T. Milton resigned his seat on the council owing to pressure of work.

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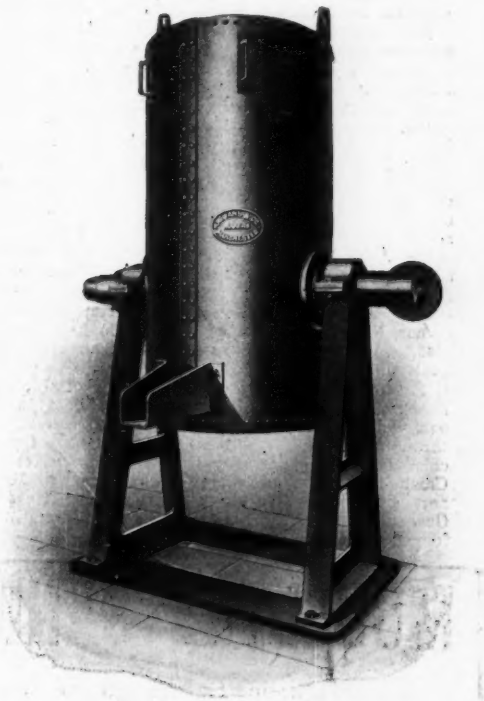

James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Deaths.

THE death has occurred of Mr. Finlay Finlayson, consulting engineer, of Belhaven, Airdrie.

MR. W. T. PAGE, chairman of the Lincoln Wagon and Engine Company, Limited, died on September 27 last.

THE death is reported of Mr. J. E. Hodgkin, managing director of the Pulsometer Engineering Company, Limited, Reading.

MR. E. ADAMS, managing director of Hulse & Company, Limited, Ordsal Works, Salford, Manchester, died on Saturday, September 28.

MR. R. W. REYNOLDS, a director of Cosens & Company, Limited, engineers and ironfounders, Commercial Road, Weymouth, died recently at the age of 83 years.

THE death took place recently of Mr. E. Davy, of the firm of J. Davy & Company (Elsecar), Limited, ironfounders, Elsecar Foundry, Elsecar, near Barnsley, in his seventy-first year.

MR. J. H. CHARLTON, of The Grove, Waltham, head of the Grimsby firm of Charlton & Company, Limited, Church Street Engine Works, died on October 11, at Bournemouth, at the age of 56 years.

THE death occurred recently, at his residence, Lancaster Road, Birkdale, of Mr. Frederick Monks, chairman of the firm of Monks, Hall & Company, Limited, iron and steel makers, of Atherton Quay, Warrington, Lancs., at the age of 77 years.

MR. CHARLES BARNARD, a director of Barnards, Limited, Norfolk Ironworks, Norwich, died recently in London. The deceased gentleman was the eldest son of the late Mr. Charles Barnard, who founded the business, and had been on the board for many years.

MR. J. T. VAUGHAN, a director of Vaughan & Son, Limited, of the Royal Ironworks, Ambrose Street, West Gorton, Manchester, and a partner of the Vaughan Pulley Company, Vaughan Street, West Gorton, Manchester, died recently, at Lille, France.

MR. D. DONCASTER, at one time a director of Daniel Doncaster & Sons, Limited, crucible steel makers and iron merchants, of 41, Doncaster Street, Sheffield, died recently, at the age of 77 years. The deceased gentleman was one of the sons of the founder of the business, but retired from active association with it several years ago.

MR. JOHN ROBERTON, formerly of the firm of Cameron & Roberton, Limited, Star Foundry and South Bank Ironworks, Kirkintilloch, died on October 18, aged 74 years. Mr. Roberton entered into partnership with Mr. Cameron and purchased the South Bank Ironworks in 1868. For a number of years he took an active part in local public affairs.

THE death is reported, at the age of 70, of Mr. Thomas Bennett, of Blaendare House, Pontypool, who was well known in Monmouthshire engineering circles through holding the position for a number of years of chief engineer at Messrs. Guest, Keen & Nettlefolds' Cambrian Works. About eighteen years ago Mr. Bennett started the Pontypool Foundry and Engineering Company, but failing health caused his retirement about four years ago.

THE death took place recently, at his residence, 5, Eglinton Terrace, Ayr, of Mr. James M. Jack, general secretary of the Associated Ironmoulders of Scotland. The deceased gentleman joined the society in the year 1867, and at his death had completed 45 years' membership. While holding the position of President of the Executive, at the death of Mr. John Fraser, who was his predecessor in the position of General Secretary of the society, Mr. Jack was elected General Secretary in the year 1879, thirty-three years ago.

THE death is announced of Mr. George B. Wood, of Derwent House, Moncrieffe Road, Sheffield, which occurred on October 1. Born at Stratford 78 years ago, he served his apprenticeship with the Great Eastern Railway Company, in the service of which he became an inspector. He went to Sheffield over forty years ago, and for upwards of thirty years was connected with the firm of Cammell, Laird & Company, Limited, first in the capacity of assistant to the managing director, and subsequently as general works manager.

THE death is announced from Ilkley, where he had been living in retirement for some years, of Mr. George Wilkinson, one of the best-known Keighley engineers of the older generation, at the age of 84 years. The deceased did much for the development of the Keighley machine tool making industry, and, with the late Mr. Francis Butterfield, Mr. G. Croft, and others, he founded, in Greengate, the business of Croft, Butterfields & Wilkinson. Six years later, after the erection of the new premises in Dalton Lane, the brothers Butterfield took over the whole concern. Eventually Mr. Wilkinson founded, with his sons, a new business in Bradford Road.

A HOST of business acquaintances and personal friends will learn with great regret of the sudden death, at Harrogate, of Mr. John Wood, J.P., senior member of the firm of John Wood & Sons, Limited, Barley Brook Foundry, Wigan. The deceased gentleman, who was 72 years of age, studied engineering at the Haigh Foundry, and subsequently entered into partnership with the late Alderman Gee, of Wigan. Together they founded the Barley Brook Foundry about 20 years ago. On the death of Mr. Gee, Mr. John Wood took over the sole control of the business, and was joined in partnership by his three sons. As manufacturers of colliery engines and winding gear the firm enjoys a world wide reputation.

THE death took place on October 11, at Lyndhurst, Chapeltown, Leeds, of Mr. Robert Middleton, owner of the Sheepscar Foundry, Meanwood Road, Leeds. Mr. Middleton, who was 65 years of age, had been seriously ill for about two months. He was a son of the late Mr. William Middleton, and had been connected with the trade of Leeds practically all his life. He took over the control of Sheepscar Foundry in the year 1870, when it was a small undertaking, and by his energy and enterprise made the concern a noteworthy success. He was on the Leeds Committee of the Engineering Employers' Federation and a member of the Engineering Committee of the Leeds University. His son, Mr. R. C. Middleton, has been at the Sheepscar Foundry for some years.

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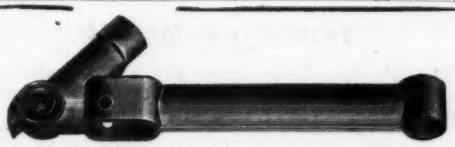

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From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End Sept., 1912.	End Sept., 1911.
Iron—Scotch pig warrants ton	*72/7½	*52/3
—Middlesbro' warrants .. ton	67/0	46/6
—W.C. M/nos Bessemer ... ton	85/0	63/6
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chill bars GMB ton	£75 5 0	£55 10 0
—Stock, Europe and afloat tons	46,341	78,936
Tin—English ingots ... ton	£212 0 0	£196 0 0
—Straits ... ... ton	£229 5 0	£190 5 0
—Stock, London, Holland, U.S.A., and afloat ...tons	11,742	14,748
Lead—English pig ... ton	£19 15 0	£16 0 0
Spelter—Ord. Silesian ... ton	£27 10 0	£26 7 6
Quicksilver (75lb)... bottle	£8 5 0	£8 10 0
Antimony—Regulus ... ton	£39 0 0 £40 0 0	£23 0 0
Aluminium—Ingot ... ton	£85 0 0	—

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 12 6	to	6 0 0
,, 3 to 4 in.	5 7 6	to	5 10 0
,, 5 to 8 in.	5 5 0	to	5 7 6
,, 10 to 16 in.	5 5 0	to	5 7 6
,, 18 to 24 in.	5 5 0	to	5 7 6
Chairs	4 7 6	to	4 10 0
Floor plates (open sand)	3 10 0	to	3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 12s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £2 16s. 6d.; all per ton, f.o.b., London. Copper (clean), £68 10s. 0d.; brass (clean), £45 10s. 0d.; lead (usual draft), £17 10s. 0d.; Zinc, £21 15s. 0d.; all per ton delivered merchant's yard.

THE death took place, on October 21, of Mr. Charles David Phillips, J.P., the well-known Monmouthshire engineer, who died at his residence, The Gaer, Newport, after an illness which had prostrated him for about six months. The deceased gentleman was the son of the late Mr. Charles Phillips, of Newport, and was born in 1845. He was, as a youth, apprenticed to the engineering profession. When he completed his articles he made very rapid advancement in a variety of fields. He was soon proprietor of an engineering establishment, and ultimately took extensive premises known as the Emlyn Works at Newport, together with works at Gloucester, and branches in London and Cardiff. He was a member of the Iron and Steel Institute, of the Institution of Mechanical Engineers, and of the South Wales Institute of Engineers.

WE regret to announce the death of Mr. Vaughan Pendred, who was for nearly 40 years the editor of our well-known contemporary, the "Engineer," an announcement which will be received with deep regret by his many friends in the engineering industry. The deceased gentleman was born in Ireland in 1836, and in early life became known to Mr. Colburn, the editor of the "Engineer" at that time, by his letters, and when he came to London to look for work Mr. Colburn assisted to find him an opening in a small Staffordshire works. After a short period, however, his letters on engineering subjects attracted the attention of Mr. Passmore Edwards, the proprietor of the "Mechanic's Magazine," and he was asked to become editor of that paper. Two years or so later, in 1865, when Mr. Colburn resigned, Mr. Pendred was appointed to the editorship of the "Engineer," in which position he remained till his retirement in 1905, when he was succeeded by his second son.

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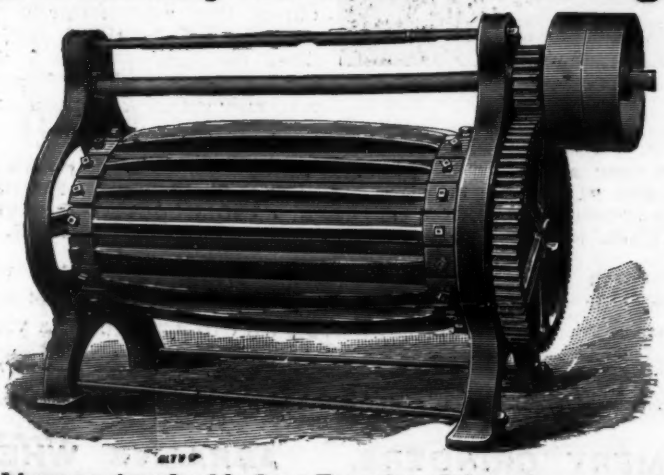

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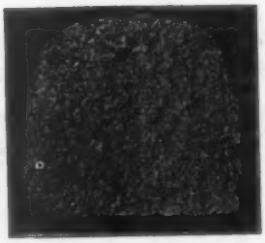
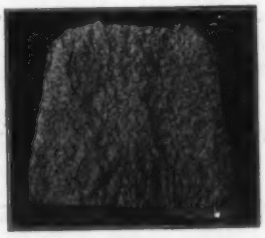

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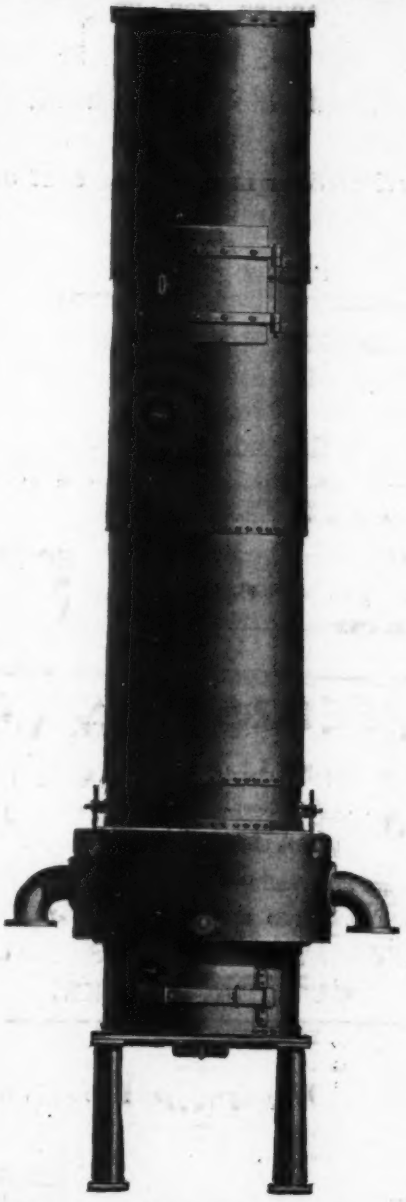

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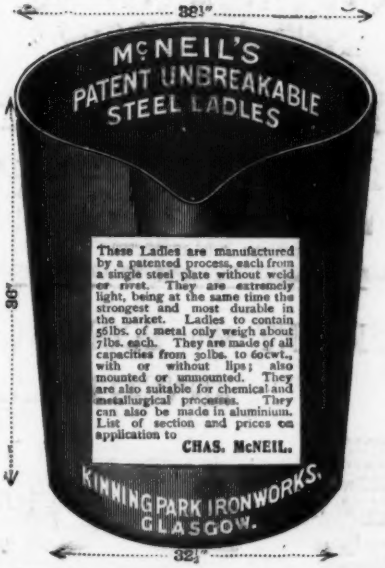
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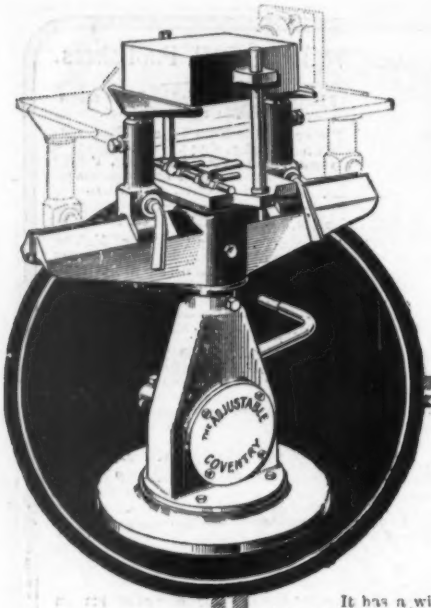

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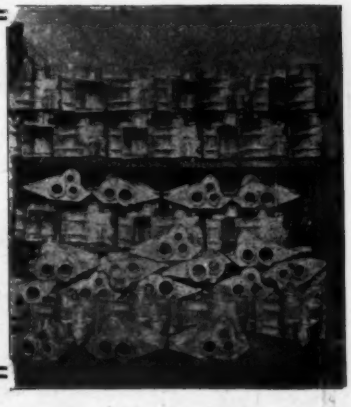

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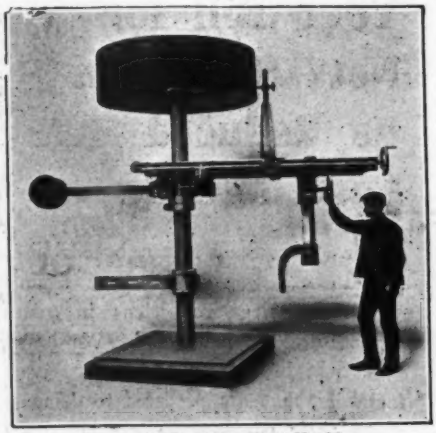

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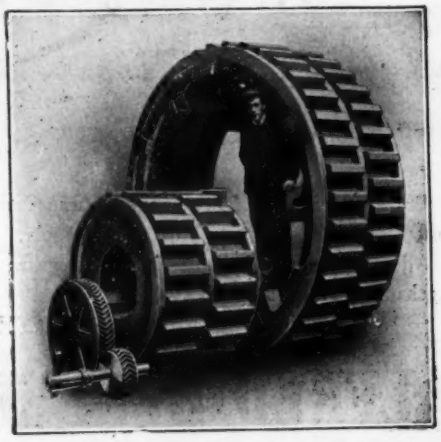

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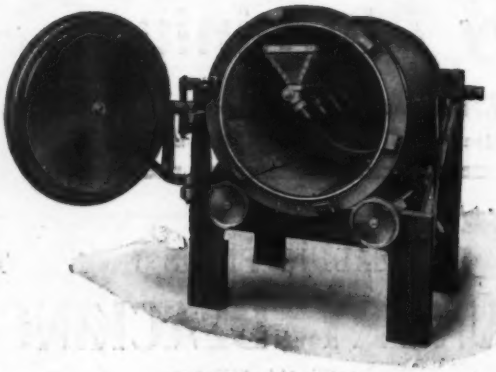

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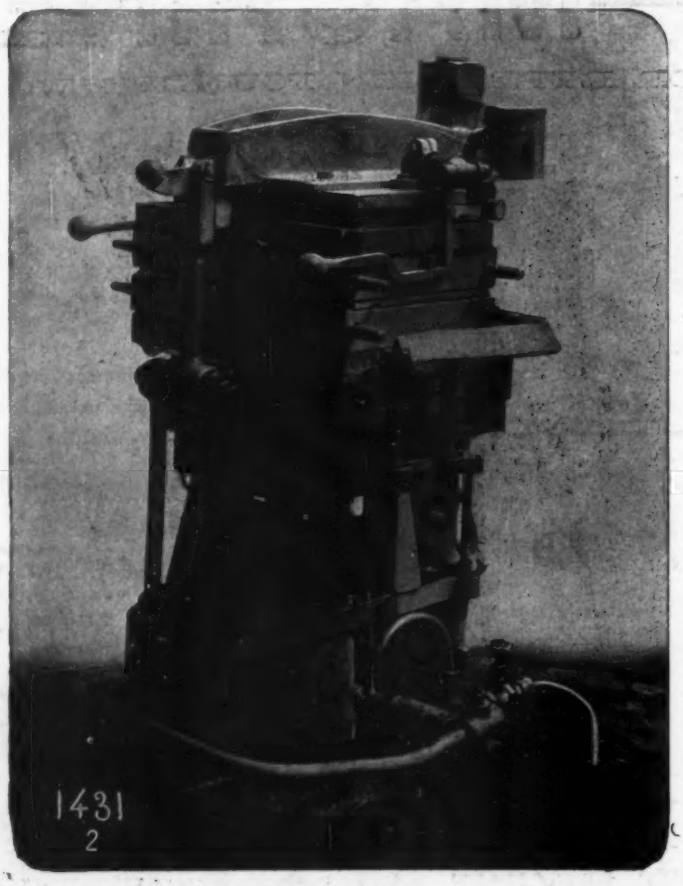

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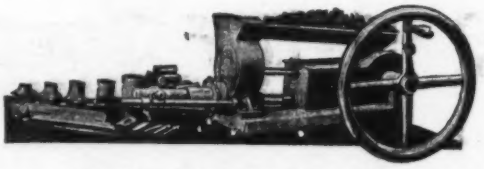

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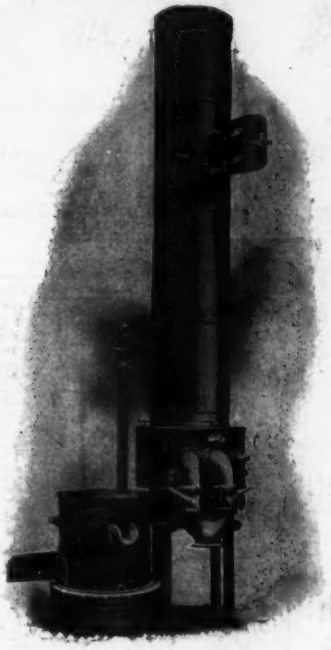

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